Vesta Copy

ECE 300
Spring Semester, 2008
HW Set #6

Due: March 4, 2008 **Name** wlg
Print (last, first)
wlg
Version 2.0

Check according to your section: _____ 8:10 AM; _____ 11:10 AM

Use engineering paper. Work only on one side of the paper. Use this sheet as your cover sheet, placed on top of your work and stapled in the top left-hand corner. Number the problems at the top of the page, in the center of the sheet. **Do neat work. Underline your answers. Show how you got your equations. Be sure to show how you got your answers.** Each problem counts 15 points.

From the text:

7.6 Ans: $v(t) = 4e^{-12.5t}$ V; $t \geq 0$

7.8 Ans: (a) $R = 50\ \Omega$, $C = 5$ mF; (b) $\tau = 0.25$ s; (c) $W_c = 250$ mJ; (d) $t_{disp} = 86.6$ msec

7.17 Ans: $v_o(t) = -2e^{-16t}\,u(t)$ V

Also use p-spice to simulate and plot $v_o(t)$. Show a caption below your p-spice diagram that Says CIRCUIT USED TO PLOT V_o (give your full name here)

PP 7.3

7.22 Ans $i(t) = 10e^{-2.5t}$ A $t \geq 0$
$v(t) = -40e^{-2.5t}$ V $t \geq 0$

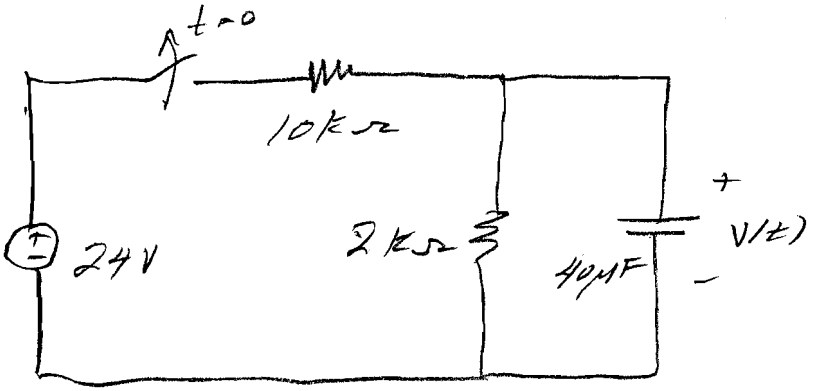
wlg

ECE 300

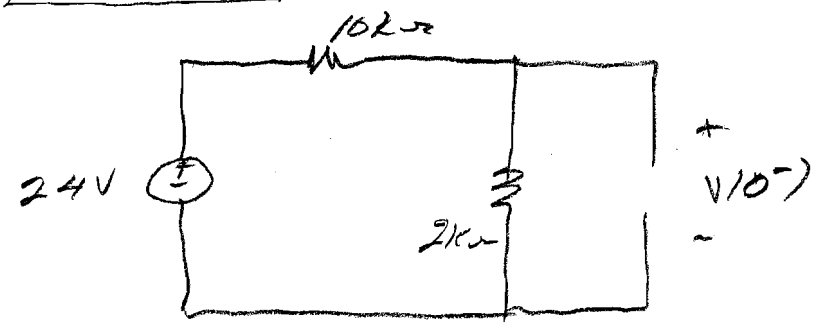
H.W. #6

Spring Semester 2008

7.6 The switch in the circuit below has been closed for a very long time and is opened at $t = 0$. Find $v(t)$ for $t \geq 0$.



For $t < 0$



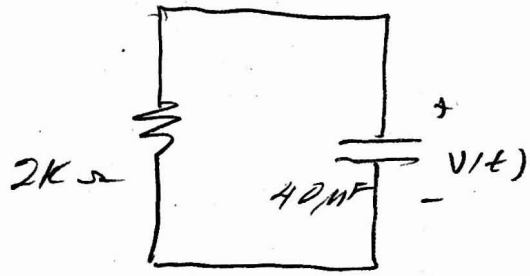
$$v(0^-) = \frac{24 \times 2k}{10k + 2k} = 4\,V$$

Voltage across the capacitor does not change instantaneously. So

$$v(0^+) = v(0^-) = 4\,V$$

7.6 cont.

$t > 0$



$R_{eq} = 2k\Omega \quad C = 40\mu F$

$\tau = RC = 2\times10^{3} \times 40\times10^{-6} = 80\times10^{-3}$

$\tau = .08$ sec.

From having solved the above circuit from we know

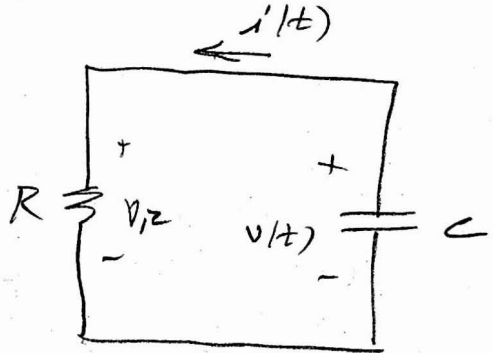
$$v(t) = v(0^+)e^{-\frac{t}{\tau}}$$

$$v(t) = 4e^{-\frac{t}{0.08}}$$

$$v(t) = 4e^{-12.5t} \qquad t \geq 0$$

7.8 Given the following circuit. It is known that

$$v(t) = 10e^{-4t}\ V \qquad i(t) = 0.2e^{-4t}\ A$$



(a) Find R and C

$$i = -C\frac{dv}{dt} = -C\frac{d}{dt}10e^{-4t} = +4C\times 10e^{-4t}$$

$i(0) = 0.2$

$$.2 = +4\times 10\times C$$

$$\boxed{C = \frac{0.2}{40} = 0.005\ F = 5\ mF}$$

$$V_R = v(t) = R\,i(t)$$

$$V_R(0) = 10e^{-4t}\Big|_{t=0} = 10 = i(0)R = 0.2R$$

$$\boxed{R = \frac{10}{.2} = 50\ \Omega}$$

(b) $\tau = RC = 50\times 5\times 10^{-3} = 250\times 10^{-3} = 0.25$ sec

(c) $W_c = \frac{1}{2}CV^2(0) = \frac{1}{2}\times 5\times 10^{-3}\times 10^2 = 0.25\ J$

(d) Energy will be dissipated in R.

7.8 cont

$$W_R = \frac{1}{2}\left[\frac{1}{2}CV_c^2(0)\right] = \frac{0.25}{2} = 0.125\,J$$

$$W_R = \int P_R\,dt = \int i^2 R\,dt$$

$$W_R = \int_0^{t_0} (0.2e^{-4t})^2 \cdot 50\,dt = 2\int_0^{t_0} e^{-8t}\,dt$$

$$= \frac{2}{-8}\left[t_0 - 1\right] = .25\left[1 - e^{-8t_0}\right]$$

$$.125 = 0.25\left[1 - e^{-8t_0}\right]$$

$$0.5 = 1 - e^{-8t_0}$$

$$e^{-8t_0} = 1 - .5 = 0.5$$

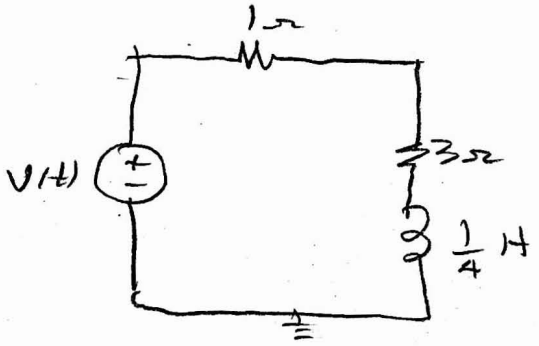
$$-8t_0 \ln e = \ln(.5) = -0.693$$

$$t_0 = \frac{.693}{8} = 0.08664\ sec$$

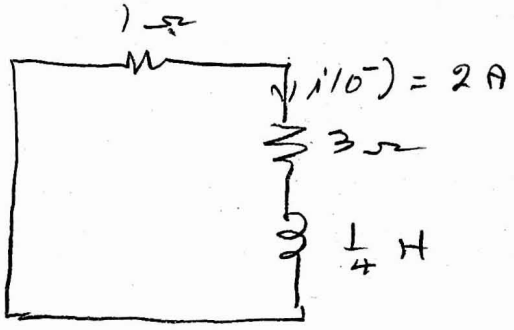
$$\boxed{t_0 = 86.6\ m\,sec}$$

7.17

Consider the circuit below. Find $v_o(t)$ if $i(t) = 2A$ and $V(t) = 0$.



with $V(t) = 0$



$R_{eq} = 4\Omega$

$i(t) = i(0^-)e^{-\frac{t}{\tau}}$

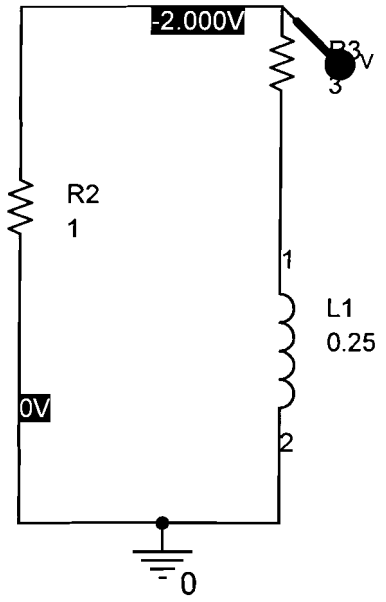
$\tau = \frac{L}{R} = \frac{1}{4\times4} = \frac{1}{16}$

$$i(t) = 2e^{-16t}\ A$$

$$v_o(t) = -1 \times i(t) = -2e^{-16t}\ A$$

Simulation next.

Call it LC7_17



Positive IC is from 1 to 2

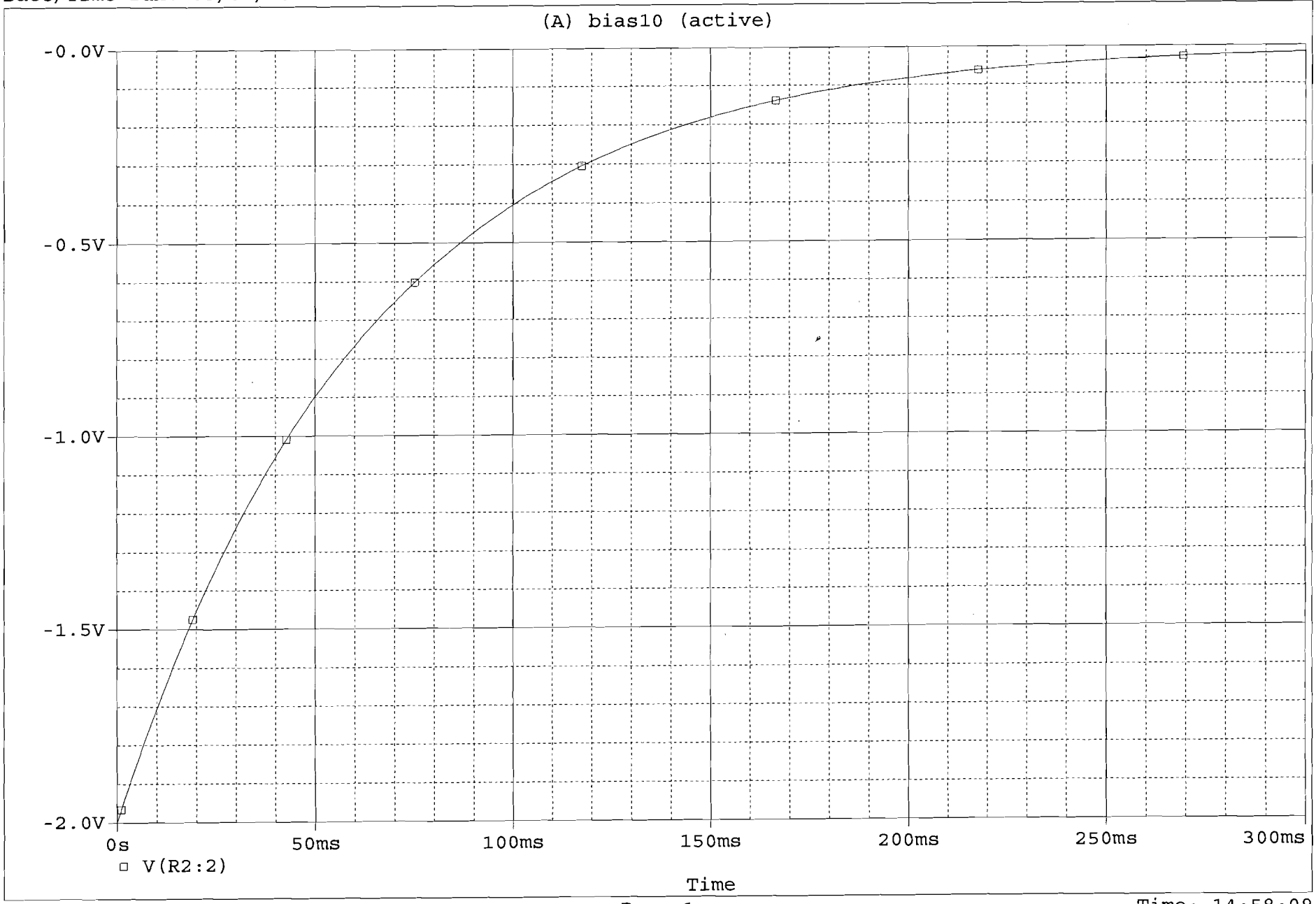
We want to go 2 to 1 so we use -2

Simulation for Problem 7_17 (LC7_17) Walter Green

** Profile: "SCHEMATIC1-bias10" [C:\ORCAD\ORCAD_10.0_DEMO\LC7_17-PSpiceFiles\SCHEMATIC1\bias10.sim]

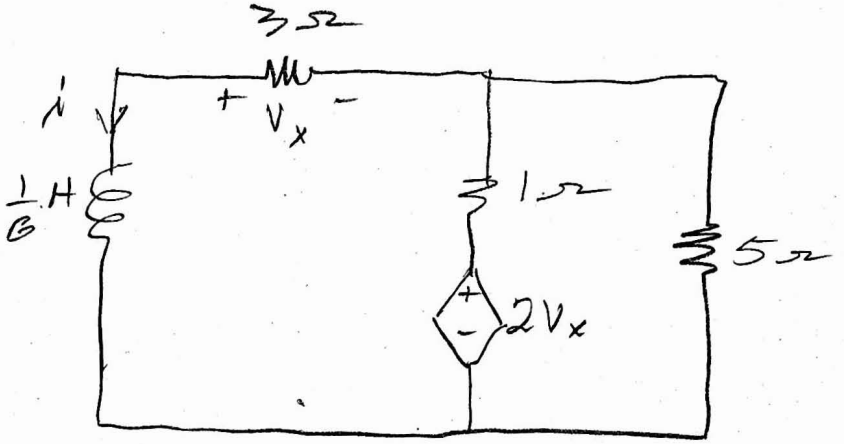
Date/Time run: 03/03/08

Temperature: 27.0



PP 7.3

Find $i(t)$ and $v_x(t)$ in the following circuit. Let $i(0^+) = 5A$

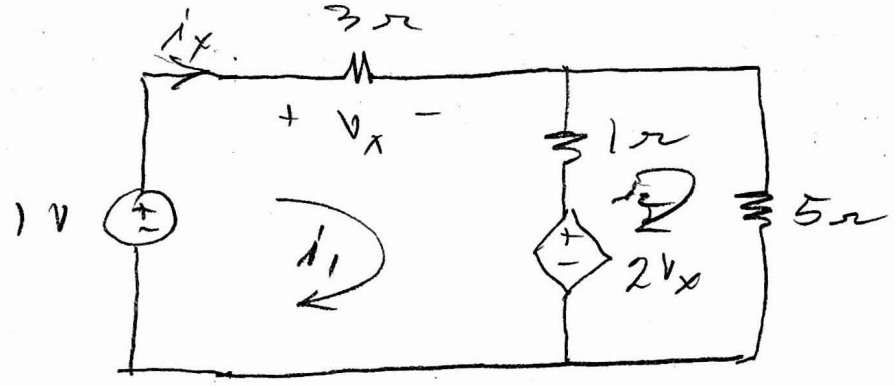


We know that $i(t)$ will be of the form

$$i(t) = I_0 e^{-\frac{R_{eq}}{L}t}$$

I_0 given as 5A

We must find R_{eq}



$$R_{eq} = \frac{1}{i_x}$$

P.P. 7.3 cont.

Writing mesh equations

$$-1 + 4i_1 - i_2 + 2v_x = 0$$

$$v_x = 3i_1$$

$$-1 + 4i_1 - i_2 + 6i_1 = 0$$

$$\boxed{10i_1 - i_2 = 1}$$

$$-2v_x + 6i_2 - i_1 = 0$$

$$-6i_1 + 6i_2 - i_1 = 0$$

$$\boxed{-7i_1 + 6i_2 = 0}$$

$$\begin{bmatrix} 10 & -1 \\ -7 & 6 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$$i_1 = 0.1132 \text{ A}$$

$$R_{eq} = \frac{1}{0.1132} = 8.83$$

$$\frac{R_{eq}}{2} = \frac{8.83}{16} = 53$$

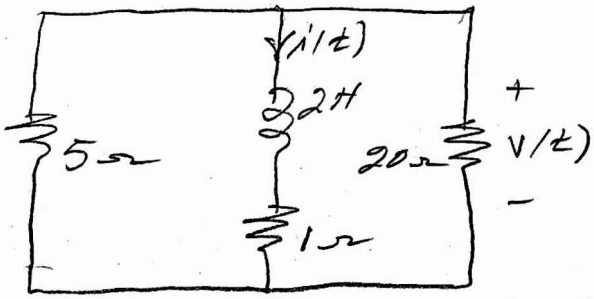
$$\therefore \boxed{i_x(t) = 5e^{-53t} \text{ A}}$$

$$v_x = -3i_x$$

$$\boxed{v_x = -15e^{-53t} \text{ V}}$$

7.22

Find $i(t)$ and $v(t)$ for $t > 0$ in the following circuit. Assume $i(0) = 10A$

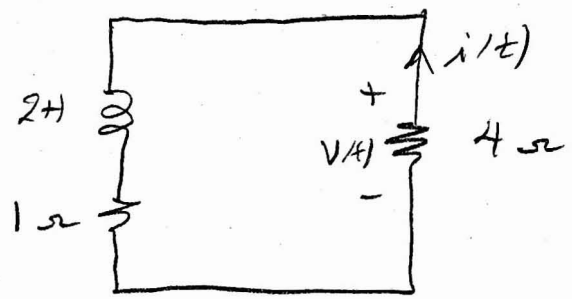


$R_{eq} = 1 + 5 \| 20$

$5 \| 20 = \frac{5 \times 20}{25} = 4\Omega$

$R_{eq} = 5\Omega$

$i(t) = i(0)\, e^{-\frac{R_{eq}}{L} t} = \underline{10 e^{-2.5t}}\ A$



$v(t) = -4\, i(t)$

$$\boxed{v(t) = -40 e^{-2.5t}\ V}$$