Desk Copy

ECE 300
Spring Semester, 2007
HW Set #7

Due: March 22, 2007 **Name**_____
wlg Print (last, first)

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 10 points.

7.24 (b) $i(t) = -10u(t) + 20u(t-3) - 10u(t-5)$ A; (d) $y(t) = 2u(-t) - 5u(t) + 5u(t-1)$

7.26 (a) $v_1(t) = u(t+1)-2u(t) + u(t-1)$ V; (b) $v_2(t) = 2u(t-2) - r(t-2) + r(t-4)$ V

7.39 (a) @ t=0, $v(t) = 4$V; $v(t) = (20-16e^{-t/8})u(t)$ V; (b) at t = 0 $v(t) = 4$V;
$v(t) = (12-8e^{-t/6})u(t)$ V

7.41 $v(t) = 10(1-e^{-0.2t})u(t)$ V (make a hand sketch (approx.) for v(t))

7.41XX Repeat problem 7.41 by programming in p-spice. Show your circuit diagram and your plot. Compare the computer plot with your sketch in 7.41.

7.46 $v(t) = 30(1-e^{-t/2})u(t)$ V

7.59 $v_o(t) = 6e^{-4t}u(t)$ V

7.60 $v(t) = 16e^{-0.5t}u(t)$ V

7.69 $v(t) = 48(e^{-t/3000}-1)u(t)$ V (make a hand sketch (approx.) for v(t))

7.69XX Repeat problem 7.69 by programming in p-spice. Show your circuit diagram and your plot. Compare the computer plot with your sketch in 7.69. Use the uA741 op amp

Wly

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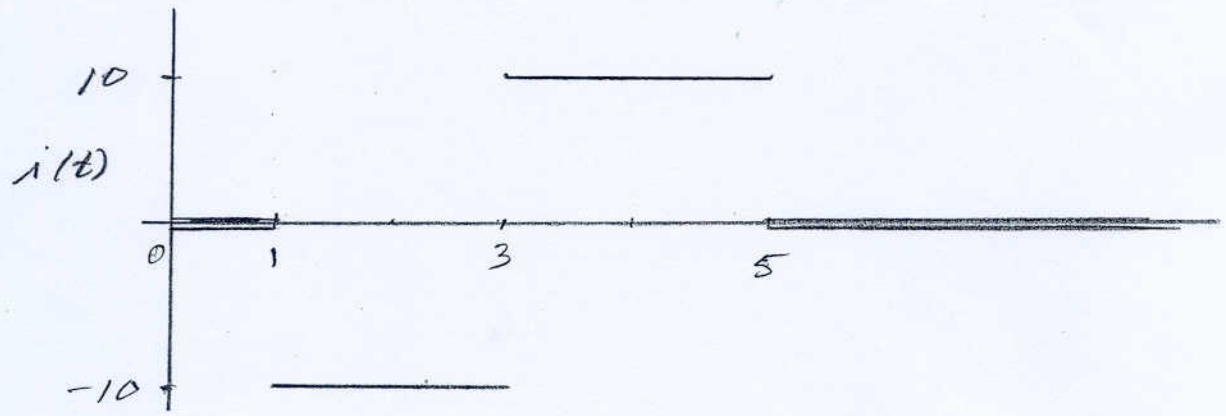
7.24

(b) Express the following signals in terms of singularity functions.

(b)

$$i(t) = \begin{cases} 0, & t < 1 \\ -10 & 1 < t < 3 \\ 10 & 3 < t < 5 \\ 0 & t > 5 \end{cases}$$



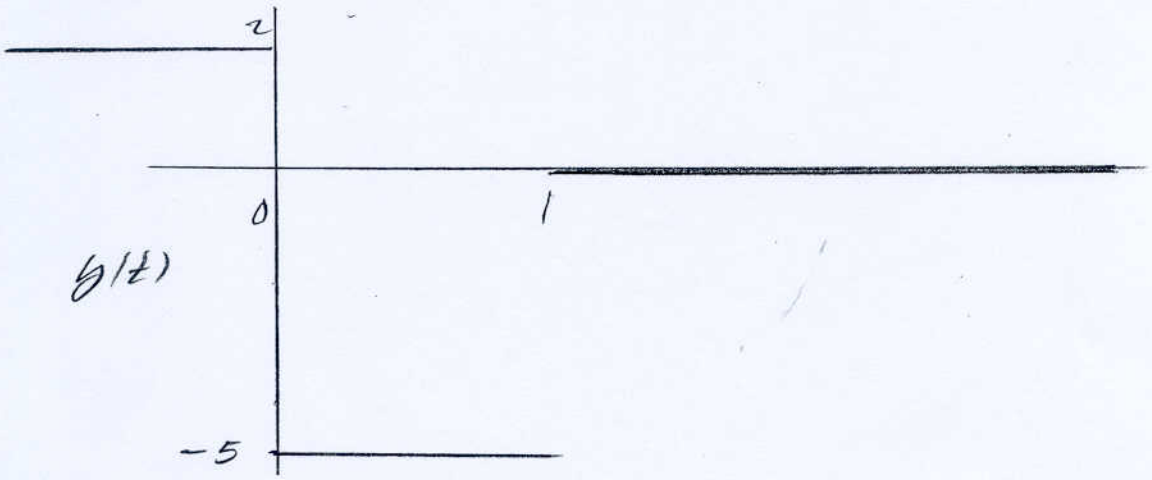
By inspection:

$$i(t) = -10\,u(t-1) + 20\,u(t-3) - 10\,u(t-5)$$

7.24 continued

(d)

$$y(t) = \begin{cases} 2 & t < 0 \\ -5 & 0 < t < 1 \\ 0 & t > 1 \end{cases}$$



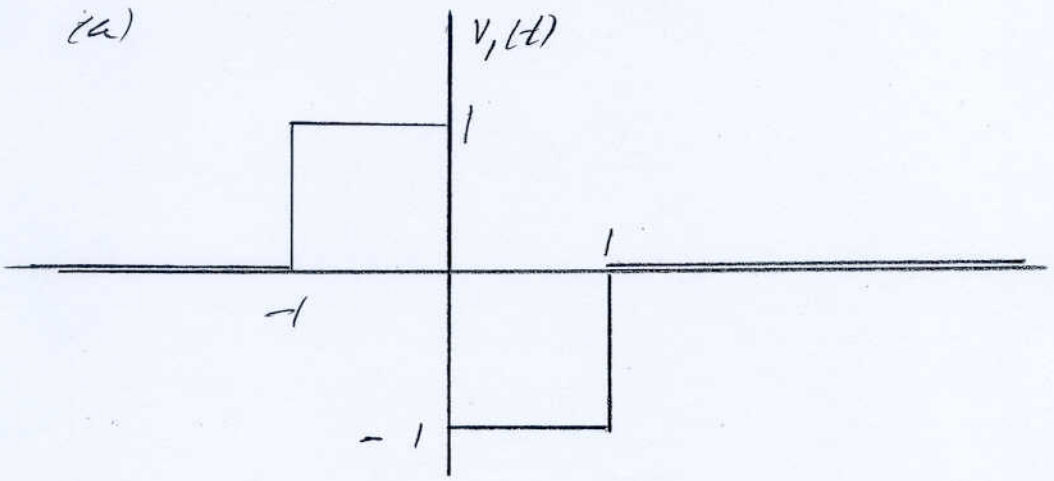
By inspection:

$$y(t) = 2u(-t) - 5[u(t) - u(t-1)]$$

(window)

7.26 Express the signals below in terms of singularity functions.

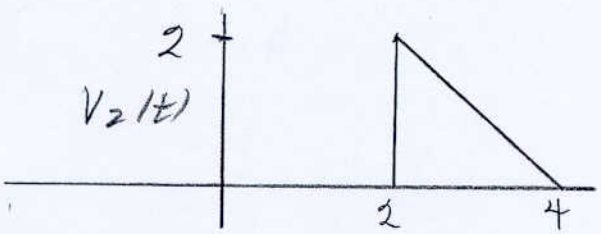
(a)



By inspection:

$$v_1(t) = u(t+1) - 2u(t) + u(t-1)$$

(b)



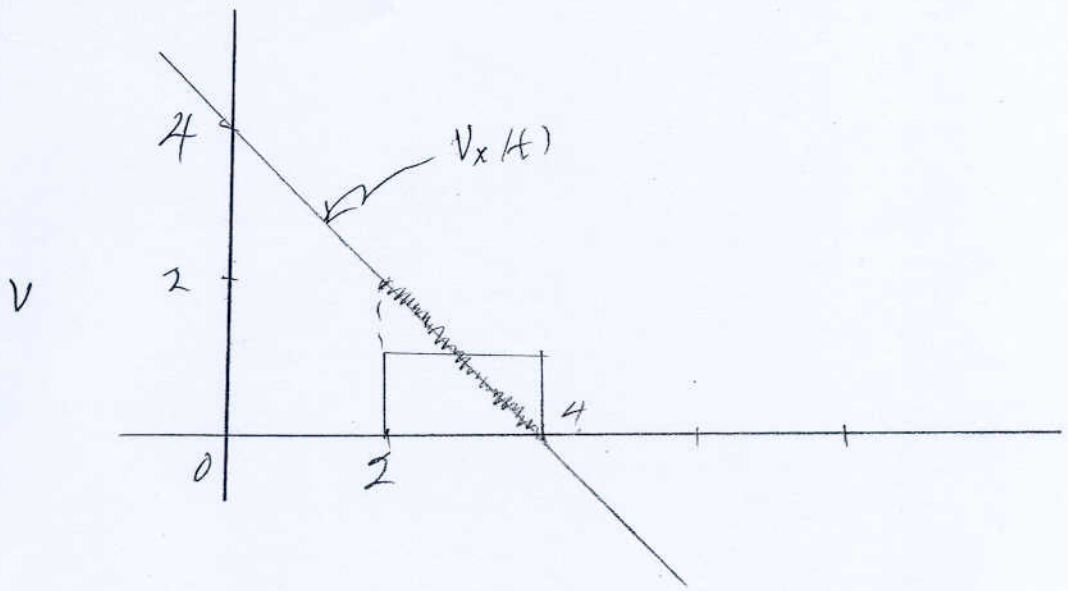
Use a gate function

$$u(t-2) - u(t-4)$$

to window out the line that falls on the above function.

see next page.

7.26 continued



$v_x(t) = 4 - t$

$v_2(t) = (4-t)[u(t-2) - u(t-4)]$

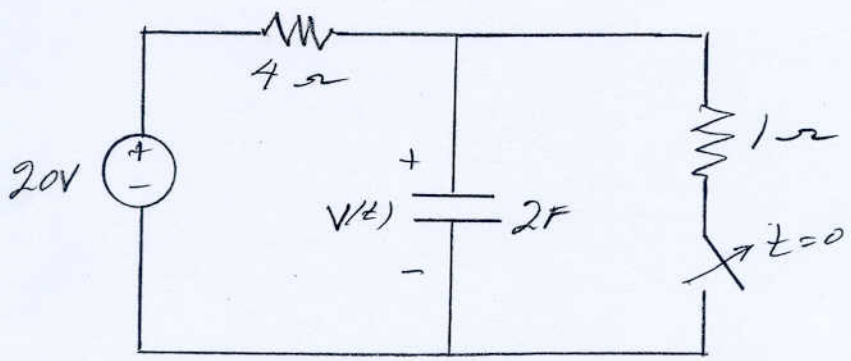
$= (4-t)u(t-2) + (t-4)u(t-4)$

$= (2 - t + 2)u(t-2) + (t-4)u(t-4)$

$= 2u(t-2) - (t-2)u(t-2) + (t-4)u(t-4)$

$v_2(t) = 2u(t-2) - r(t-2) + r(t-4)$

7.39 Calculate the capacitor voltage for $t<0$ and $t>0$ for the following circuits.



For $t<0$:

$$v(t) = \frac{20 \times 1}{1+4} = 4\,V$$

$$v(t)\Big|_{t=0^-} = v(t)\Big|_{t=0^+} = 4\,V$$

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

$$\underline{v(\infty) = 20\,V}$$

$$\tau = RC = 2 \times 4 = 8$$

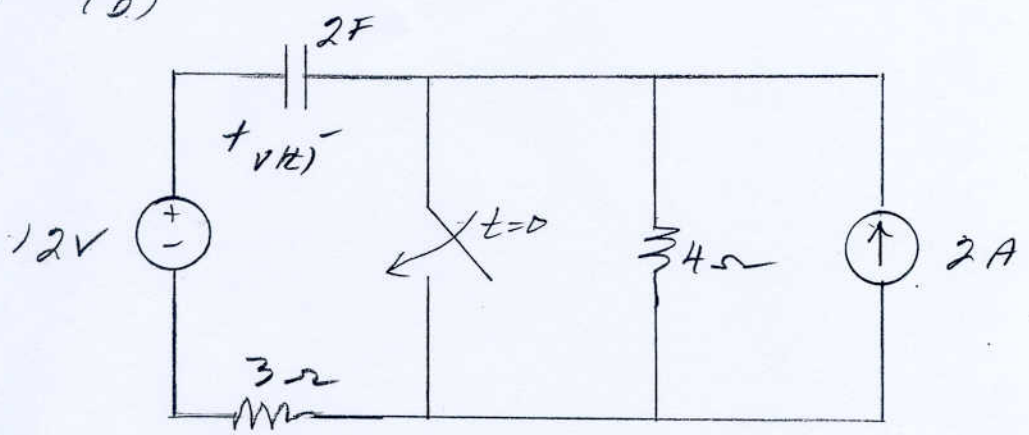
Use

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

$$v(t) = 20 + (4 - 20)e^{-\frac{t}{8}}$$

$$\underline{v(t) = \left[20 - 16e^{-\frac{t}{8}}\right] u(t)\ V}$$

7.34 (b)

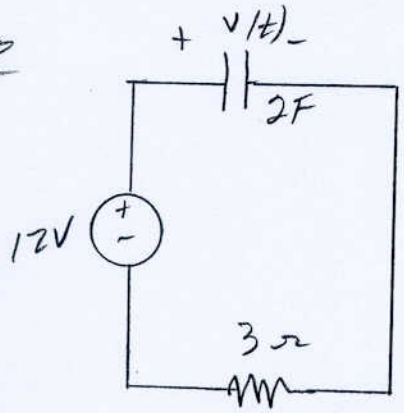


$t < 0$;

$$-12 + v(0) + 8 = 0$$

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

$t > 0$



$v(\infty) = 12\,V, \quad \tau = 6\,sec, \quad v(0^+) = 4$

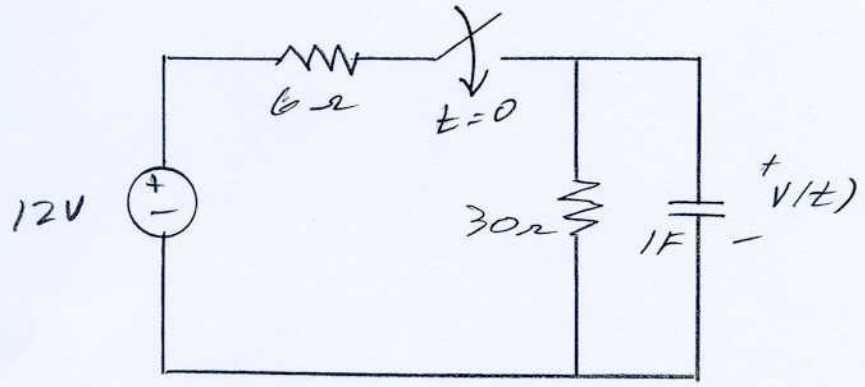
$\therefore$

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

$$v(t) = 12 + [4 - 12]\, e^{-\frac{t}{6}}$$

$$v(t) = [12 - 8e^{-\frac{t}{6}}]\, u(t) \quad V$$

7.41 For the circuit below find $v(t)$ for $t > 0$.



$t < 0$

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

$t > 0$

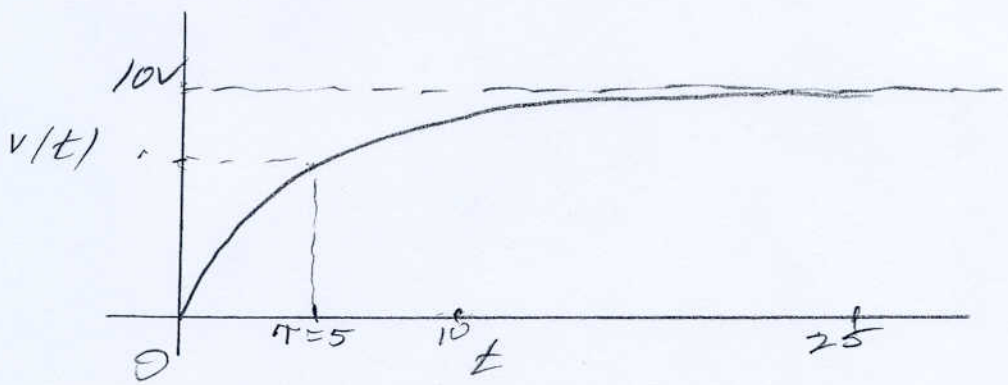
$$v(\infty) = \frac{12 \times 30}{30 + 6} = 10\ V$$

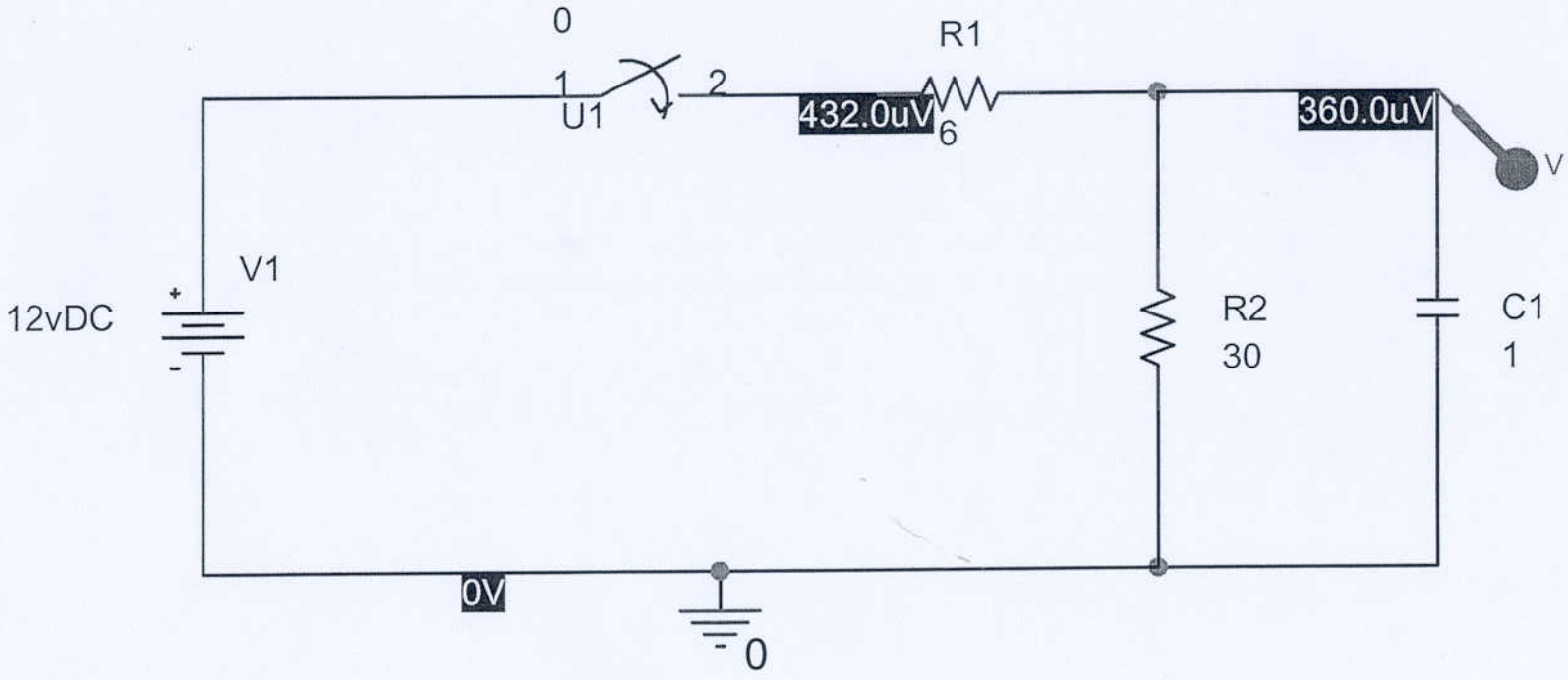
$$R_{eq} = 30 \| 6 = \frac{6 \times 30}{36} = 5\ \Omega$$

$$\tau = R_{eq} C = 5 \times 1 = 5\ sec$$

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

$$v(t) = 10 - 10 e^{-0.2t}$$




0
1
U1
2
R1
432.0uV
6
360.0uV
V
V1
12vDC
+
-
R2
30
C1
1
0V
0

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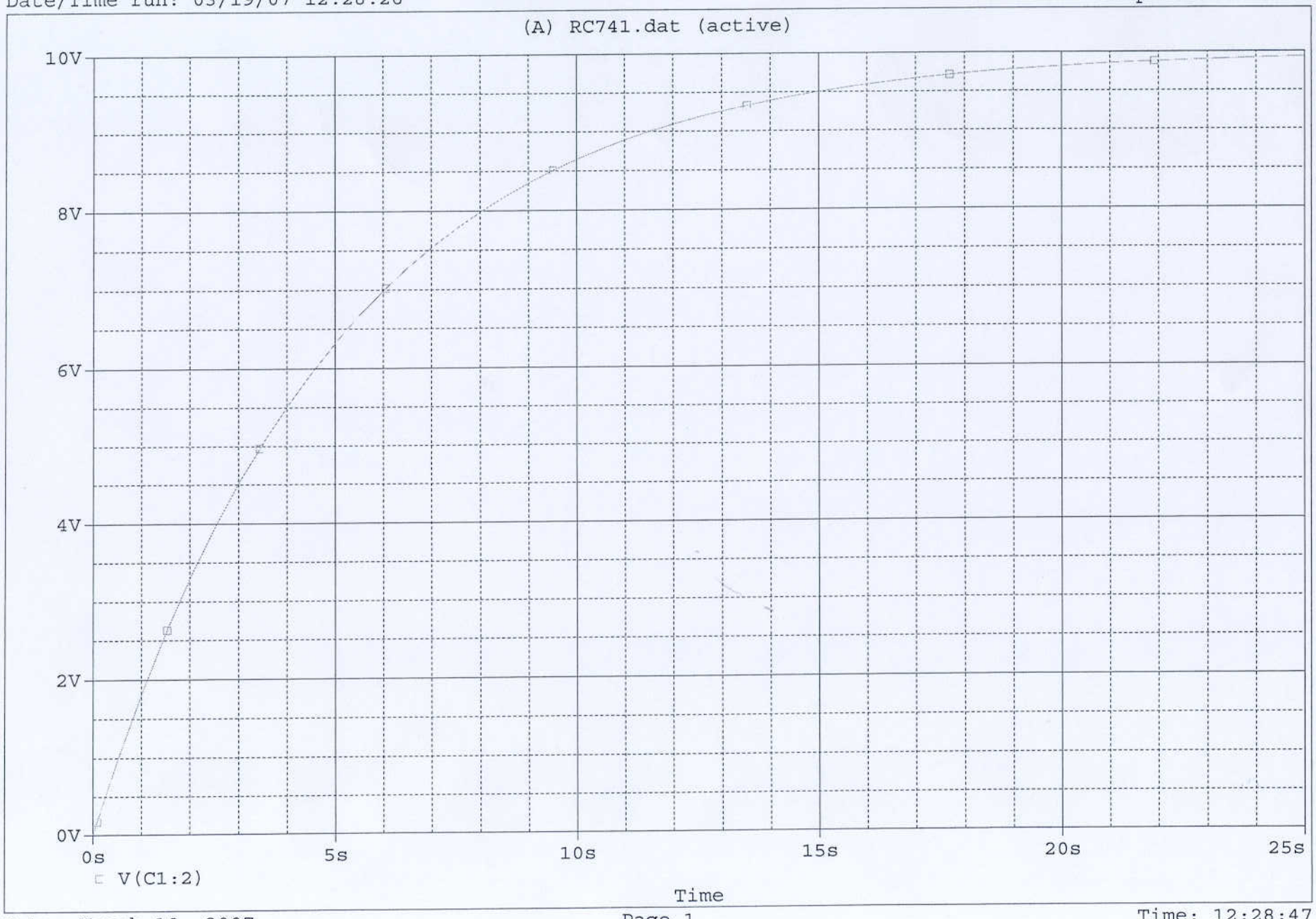
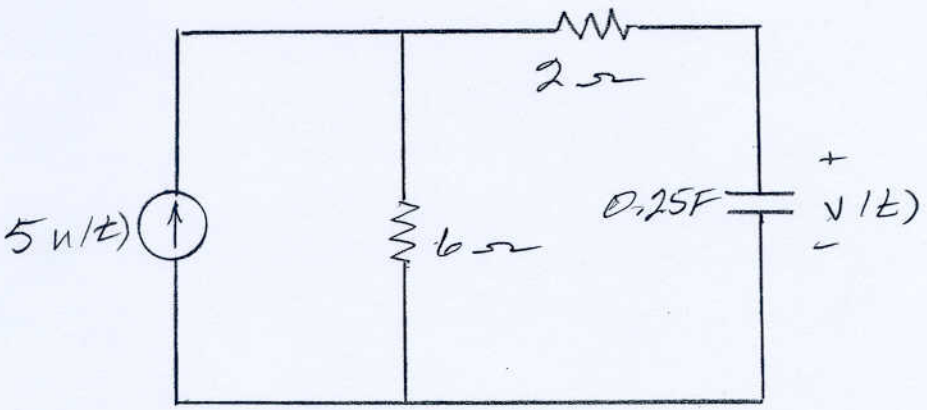


7.46

For the following circuit $i_s(t) = 5u(t)$, Find $v(t)$



$t < 0$

$$v(0^-) = 0 = v(0^+)$$

$t > 0$

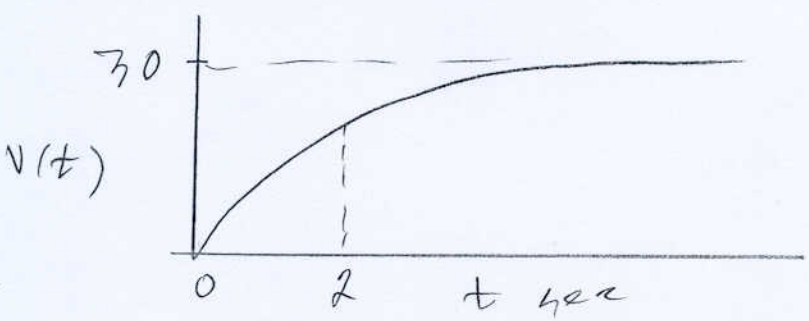
$$v(\infty) = 30\,V$$

$$\tau = R_{eq} C \; ; \quad R_{eq} = 2 + 6 = 8$$

$$\tau = 8 \times \frac{1}{4} = 2$$

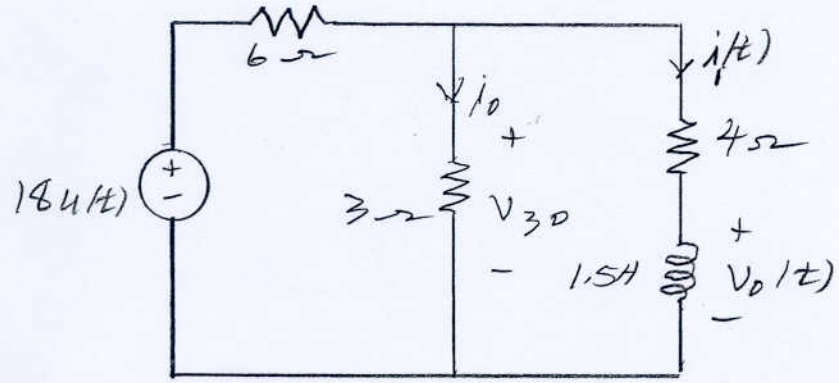
$$v(t) = v(\infty) + [v(0^+) - v(\infty)] e^{-\frac{t}{\tau}}$$

$$v(t) = 30\left(1 - e^{-t/2}\right) u(t) \; V$$



7.59

Determine $v_o(t)$ for $v_s(t) = 18u(t)$.



$t < 0$

$i_1(0^-) = 0$ (no source applied)

$i_1(0^+) = 0$ (current in the coil cannot change inst.)

$t > 0$

At $t = 0^+$, coil looks like an open circuit. $i_1(0^+) = 0$.

$$v_{30}(0^+) = \frac{18 \times 3}{3+6} = 6V$$

$$v_o(0^+) = v_{30}(0^+) = 6V$$

$$v_o(\infty) = 0$$

$$\tau = \frac{L}{R_{eq}}; \quad R_{eq} = 4 + 3 \| 6 = 6\Omega$$

$$\tau = \frac{1.5}{6} = \frac{1}{4}$$

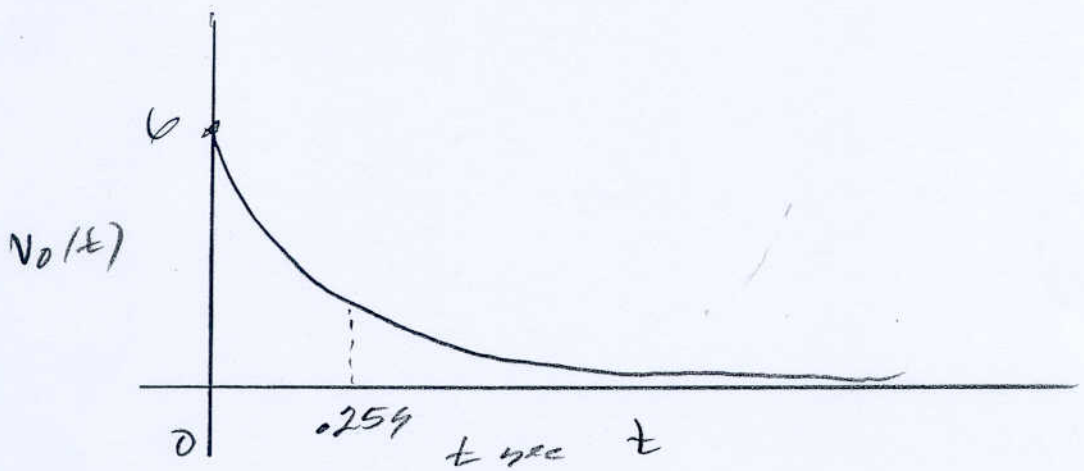
$$v_o(t) = v_o(\infty) + [v_o(0^+) - v_o(\infty)]e^{-\frac{t}{\tau}}$$

7.59

$\therefore$

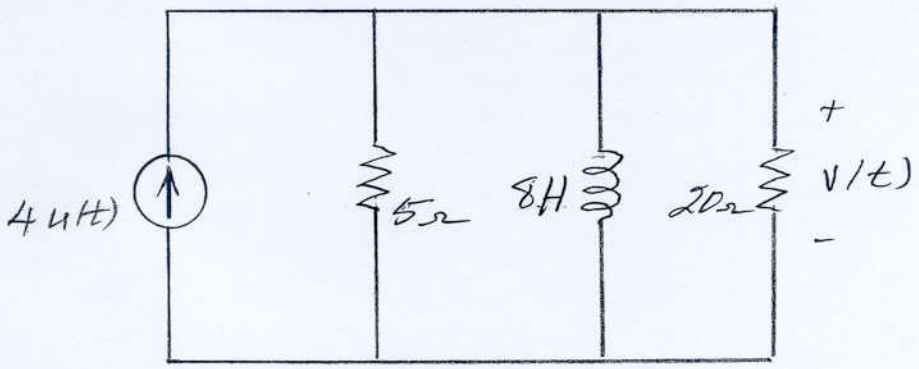
$$v_o(t) = 0 + [6-0]e^{-4t}$$

$$v_o(t) = 6e^{-4t}u(t) \ V$$



7.60

Find $v(t)$ for $t > 0$ in the following circuit: Given that the initial current in the inductor is zero.



The voltage across the 20 Ω resistor is also the voltage across the inductor.

$t < 0$

$$v(0^-) = 0$$

$t > 0$

inductor looks like an open ckt.

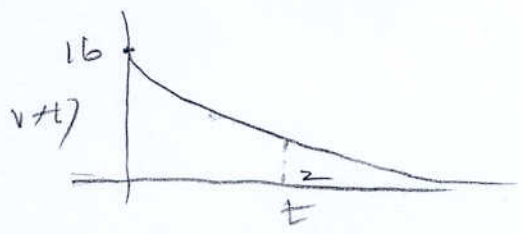
$$\therefore \quad v(0^+) = \left(\frac{4 \times 5}{5+20}\right) \times 20 = 16\,V$$

$$v(\infty) = 0 \quad \text{(inductor looks like a short — thus } v(\infty) = 0\text{)}$$

$$R_{eq} = 20 \parallel 5 = 4\,\Omega \qquad \tau = \frac{L}{R} = \frac{8}{4} = 2$$

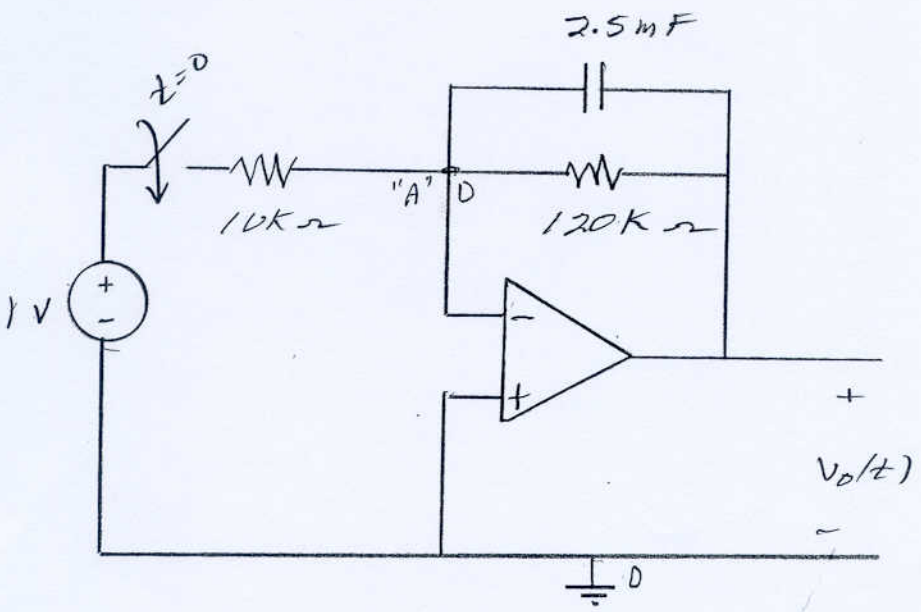
$$v(t) = v(\infty) + [v(0^+) - v(\infty)]\, e^{-\frac{t}{\tau}}$$

$$v(t) = 16\, e^{-0.5t}$$



7.69

For the op-amp circuit below find $v_o(t)$ for $t > 0$.



At "A"

$$\frac{-1}{10K} - \frac{v_o}{120K} - 2.5\times10^{-3}\frac{dv_o}{dt} = 0$$

$$2.5\frac{dv_o}{dt} + \frac{v_o}{120} = \frac{-1}{10}$$

$$\frac{dv_o}{dt} + \frac{v_o}{300} = \frac{-1}{25}$$

$$v_o(t) = v_{o_{ss}} + v_{o_t}$$

$$v_{o_{ss}} = K = \frac{300}{25} = -12 \quad \text{(will not saturate)}$$

$$v_o(t) = -12 + k_t e^{-\frac{t}{300}}$$

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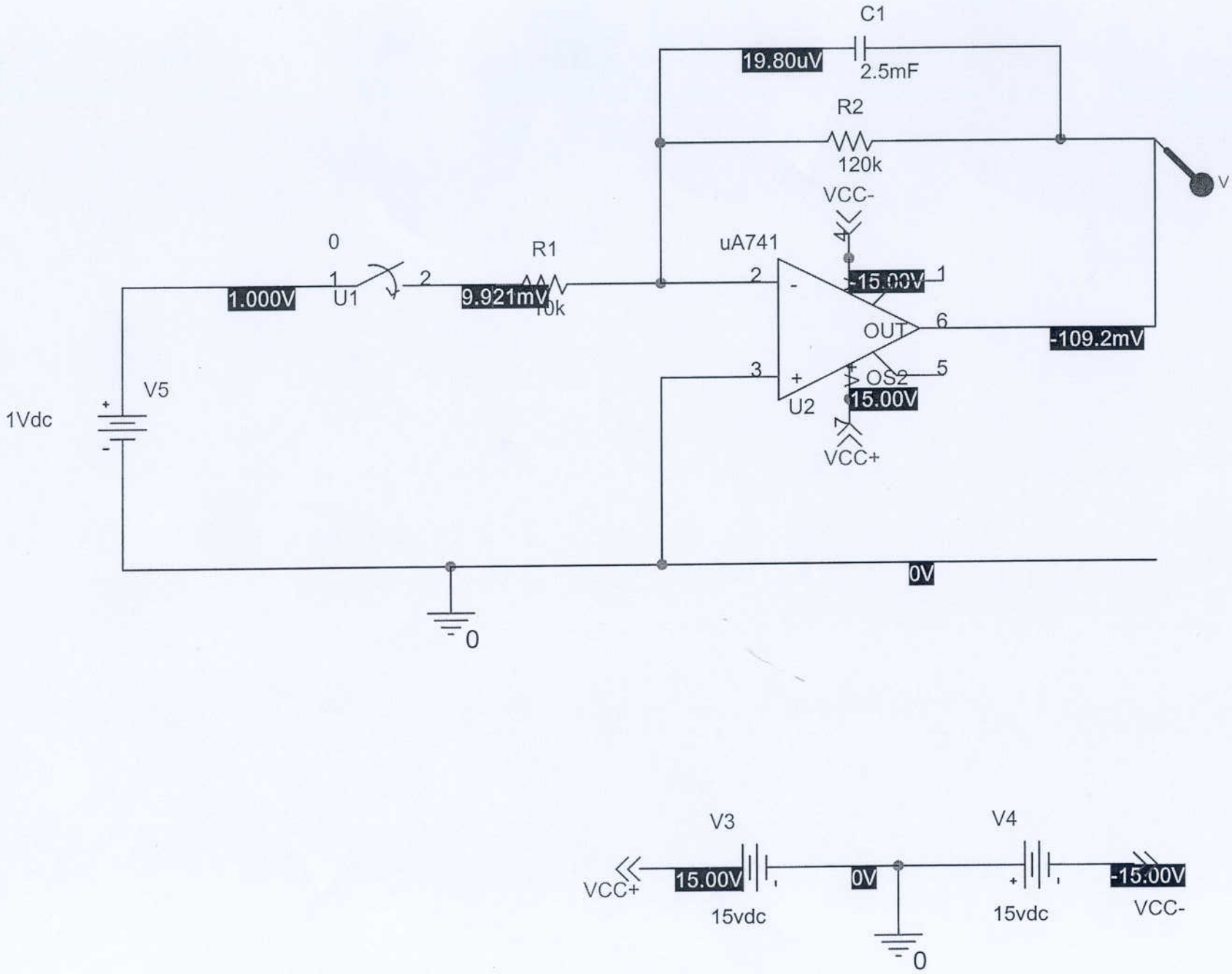
Date: March 19, 2007
Page 1
Time: 13:33:22


C1
19.80uV
2.5mF
R2
120k
V
VCC-
0
R1
uA741
1.000V
U1
9.921mV
10k
2
-15.00V
1
OUT
6
-109.2mV
3
+
OS2
5
15.00V
U2
7
VCC+
V5
1Vdc
0V
0
V3
V4
VCC+
15.00V
0V
-15.00V
15vdc
15vdc
VCC-
0

7.69 cont

$$v_o(0) = 0, \longrightarrow K_t = 12$$

$$v_o(t) = -12\left(1 - e^{-\frac{t}{300}}\right) u(t) \text{ V}$$