

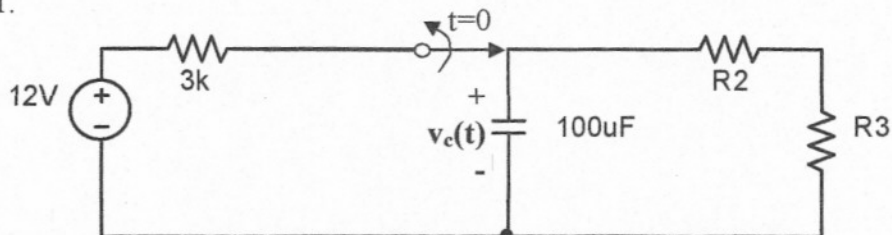
UNIVERSITY OF UTAH
ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

ECE 1270

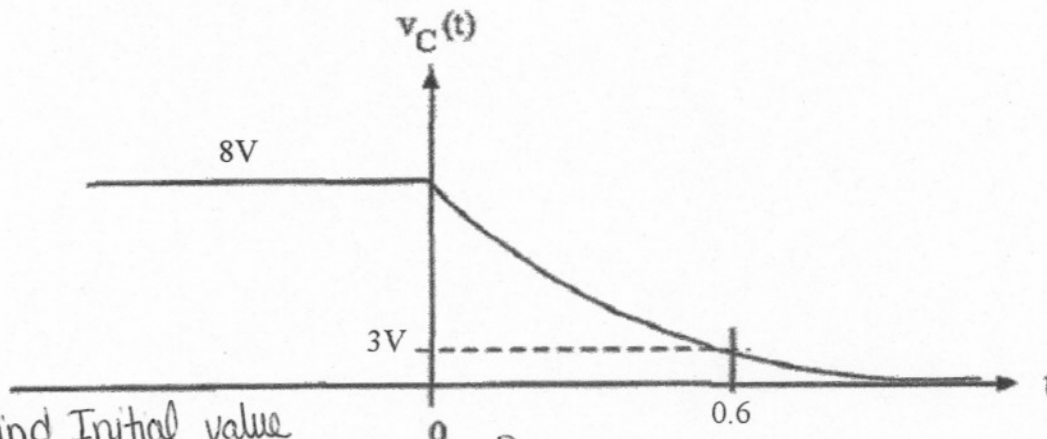
HOMEWORK #5

Summer 2007

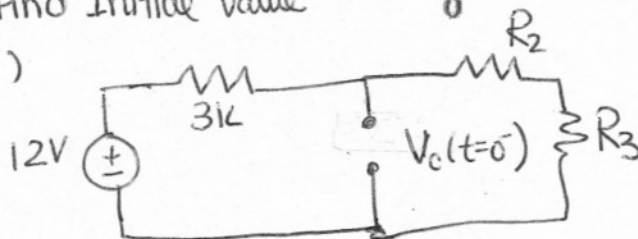
1.



After being closed for a long time, the switch becomes open at $t=0$. Find R_2 and R_3 that give the following plot for $v_c(t)$:



Step 1 - Find Initial value
($t=0^-$)



$$V_c = \frac{12(R_2 + R_3)}{R_2 + R_3 + 3k}$$

From graph, $8 = v_c(t=0^-)$

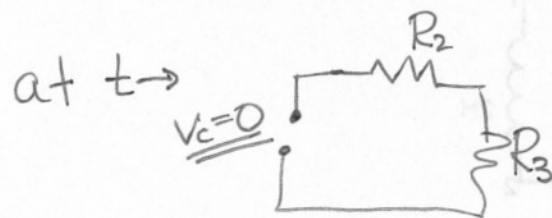
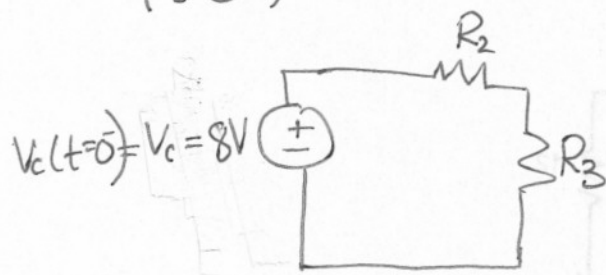
$$\therefore 8 = \frac{12(R_2 + R_3)}{(R_2 + R_3 + 3k)} \Rightarrow$$

$$8R_2 + 8R_3 + 24k = 12R_2 + 12R_3$$

$$24k = 4(R_2 + R_3)$$

$$\therefore (R_2 + R_3) = \frac{24k}{4} = 6k \Omega$$

1 (cont.)
at $(t=0^+)$



$$\tau = (R_2 + R_3)C$$

$$\therefore V_c(t) = 0 + (8 - 0)e^{-t/(R_2 + R_3)100\mu}$$

From graph $\Rightarrow$ at $t = 0.6 \text{ sec}$. then $V_c(t) = 3V$

$$3 = 8e^{-0.6/(R_2 + R_3)100\mu}$$

$$\ln[3/8] = \ln e^{-0.6/100\mu [1/(R_2 + R_3)]}$$

$$(R_2 + R_3) = \frac{-0.6}{100\mu} \frac{1}{\ln[3/8]} \cong 6.12 \text{ K}\Omega$$

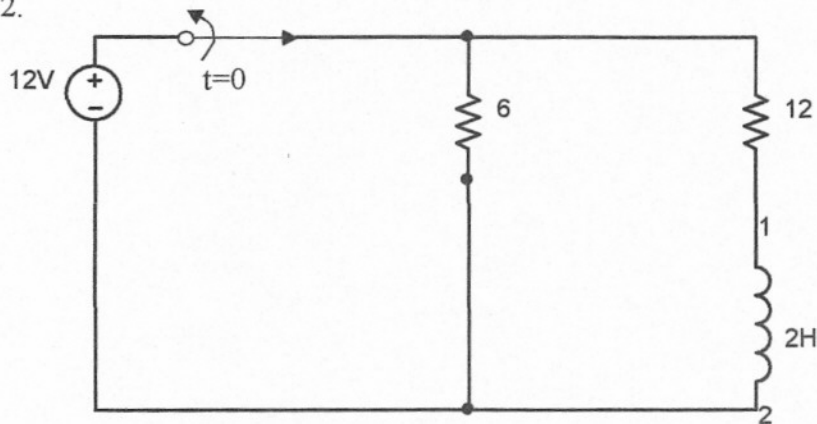
plugging in $(R_2 + R_3) = 6k$ cancels this

$\therefore$ Not a unique solution $\Rightarrow$ Any combination of

$(R_2 + R_3) = 6k$ will work

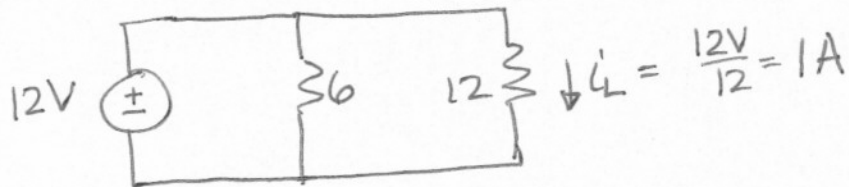
Ex: $R_2 = 3k$ $R_2 = 4k$ $R_2 = 1k$...
 $R_3 = 3k$ $R_3 = 2k$ $R_3 = 5k$

2.



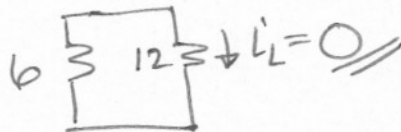
After being closed for a long time, the switch becomes open at $t=0$. Find $i_L(t)$ for $t > 0$.

Initial value $\Rightarrow (t=0^-)$



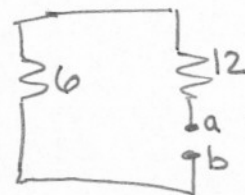
$$t=0^+ \Rightarrow i_L(t=0^-) = i_L(t=0^+) = 1A$$

Final $\Rightarrow t \rightarrow \infty$



$\Upsilon \Rightarrow$

[use final circuit position]



$$\Rightarrow R_{Th} = 12 + 6$$

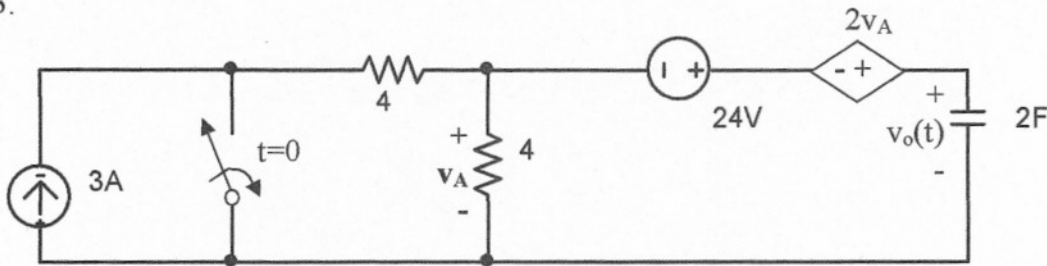
$$R_{Th} = 18$$

$t > 0$

$$i_L(t) = 1 e^{-t/(2/18)} = \boxed{1 e^{-9t} A}$$

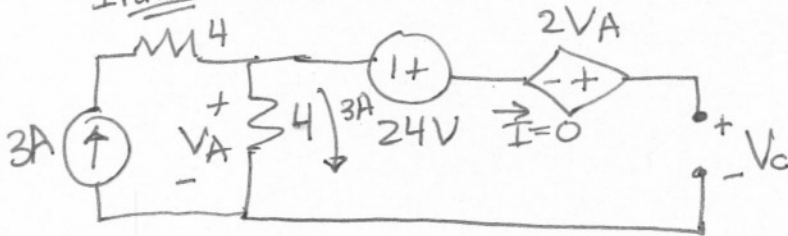
$$V_o(t) = 24 + (60 - 24)e^{-t/2(6)} = 24 + 36e^{-t/12 \text{ sec.}} \text{ V}$$

3.



After the switch has been open for a long time, it closes at $t=0$. Find $v_o(t)$ for $t > 0$.

Initial ($t=0^-$):



$$V_A = 4(3) = +12 \text{ V}$$

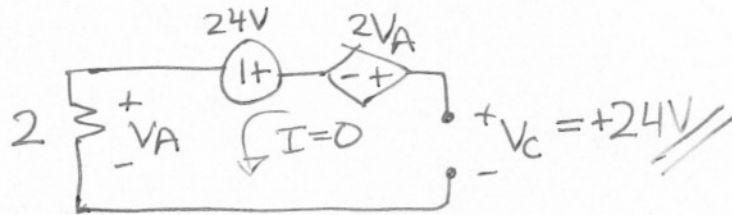
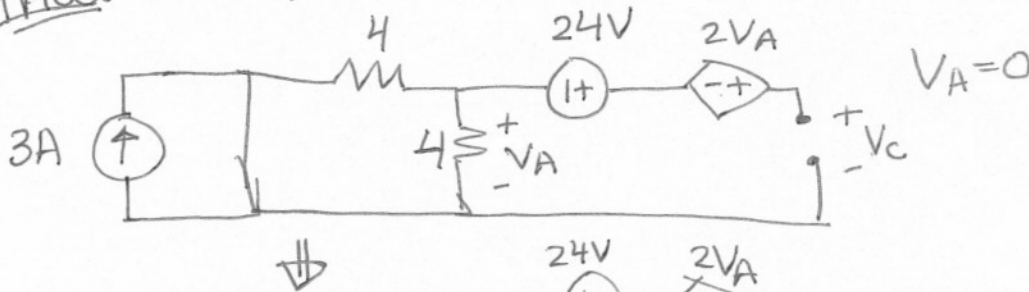
$$+V_A + 24 + 2V_A - V_C = 0$$

$$V_C = 12 + 24 + 24 = 60 \text{ V}$$

Take
Initial
value
here

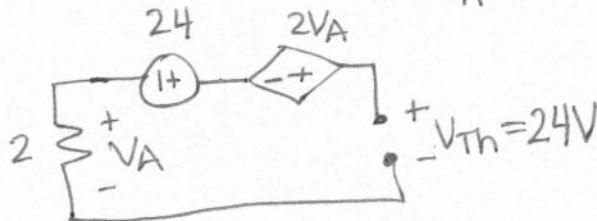
($t=0^+$) : $V_o(t) = V_C(t=0^-) = V_C(t=0^+) = \underline{\underline{60 \text{ V}}}$

Final ($t \rightarrow \infty$):



$$\therefore V_A = 0$$

$\Rightarrow$

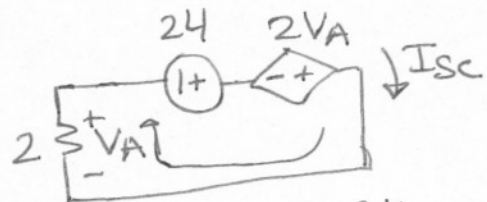


$$V_A = -I_{sc}(2)$$

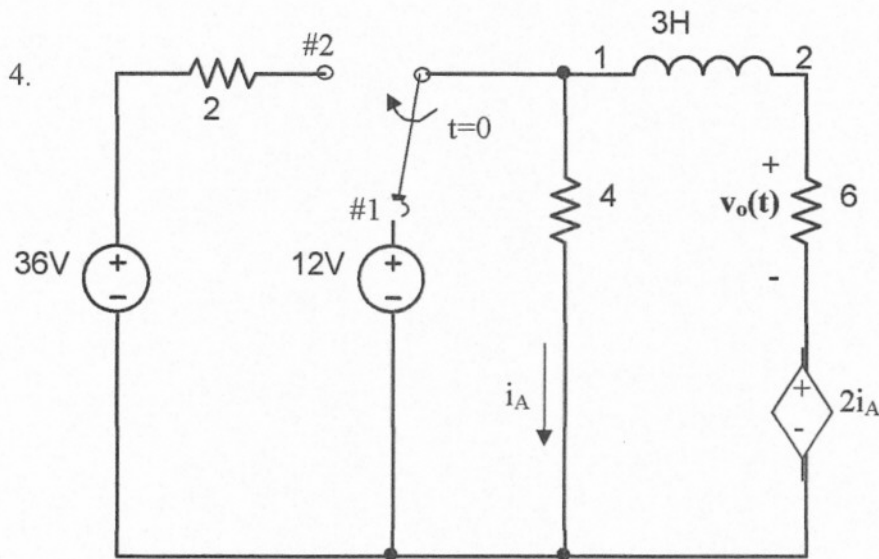
$$+V_A + 24 + 2V_A = 0$$

$$3(-I_{sc}2) + 24 = 0$$

$$I_{sc} = \frac{24}{6} = 4 \text{ A}$$

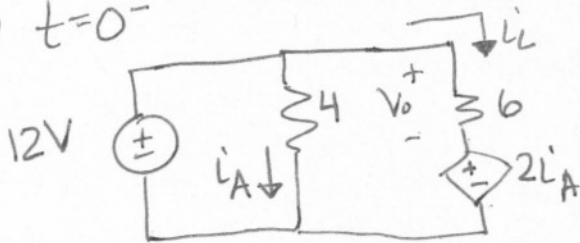


$$\therefore R_{Th} = \frac{V_{Th}}{I_{sc}} = \frac{24}{4} = 6 \Omega$$



After the switch is in position 1 for a long time, it switches to position #2 at time $t=0$. Find the output voltage $v_o(t)$ for $t > 0$.

① $t=0^-$

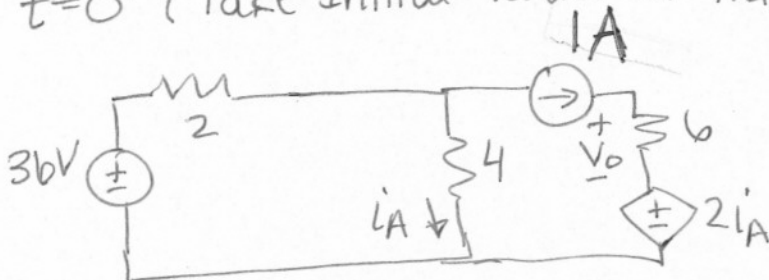


$$i_A = \frac{12}{4} = 3 \text{ A}$$

$$+12 - i_A(4) - 2i_A(6) = 0$$

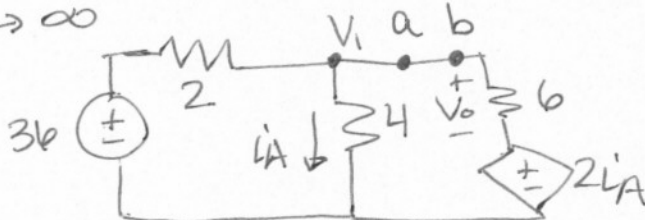
$$12 - 6 = i_A = 1 \text{ A}$$

$t=0^+$ (Take Initial value at this point)



$$\therefore v_o = 6 \text{ V}$$

$t \rightarrow \infty$



Node -V: $\frac{V_1 - 36}{2} + \frac{V_1}{4} + \frac{V_1 - 2(\frac{V_1}{4})}{6} = 0$

$$V_1 \left(\frac{1}{2} + \frac{1}{4} + \frac{1}{6} - \frac{1}{12} \right) = 18$$

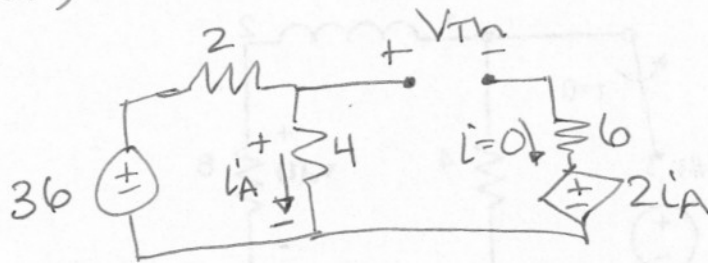
$$V_1 = \frac{18(12)}{10} = 21.6 \text{ V}$$

$$+V_1 - v_o - 2\left(\frac{V_1}{4}\right) = 0$$

$$v_o = V_1 - \frac{1}{2}V_1 = \frac{1}{2}V_1 = 10.8 \text{ V}$$

#4 (cont.)

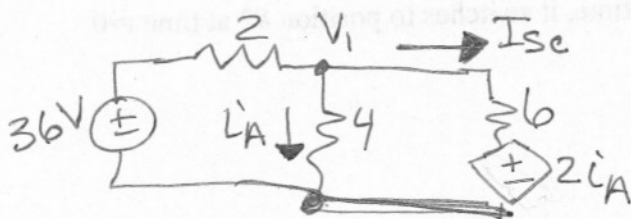
$\uparrow \Rightarrow$



$$i_A = \frac{36}{6} = 6A$$

$$+i_A(4) - V_{Th} - 0 - 2i_A = 0$$

$$V_{Th} = 6(4) - 2(6) = +12V$$



(From previous) $\Rightarrow V_1 = 21.6V$

$$\frac{V_1 - 2\left(\frac{V_1}{4}\right)}{6} = I_{sc}$$

$$\therefore I_{sc} = \frac{21.6 - \frac{1}{2}(21.6)}{6} = 1.8A$$

$$R_{Th} = \frac{V_{Th}}{I_{sc}} = \frac{+12V}{1.8A} = 6.7\Omega$$

$$t > 0, \quad V_o(t) = 10.8 + (6 - 10.8)e^{-t/(3/6.7)}$$

$$V_o(t) = 10.8 - 4.8e^{-t/45 \text{ sec.}}$$