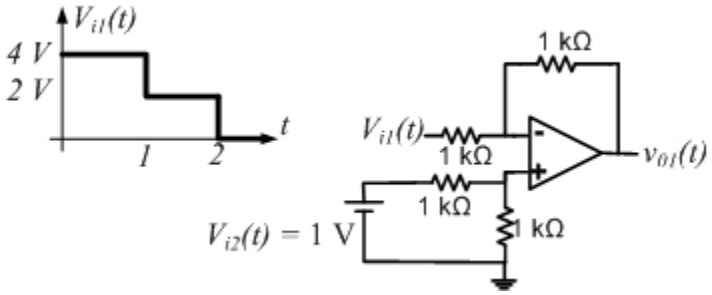
Name: _____ Page:1

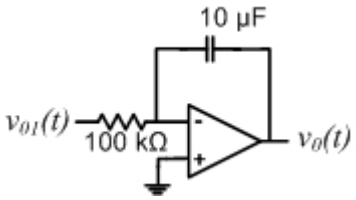
EE411 – Summer 2008, Test 1

Please, show all your work on the test sheets. A correct answer without supporting work gets no credit. One sheet of notes is permitted. Write your name in all pages. Do not unstaple. You have 60 minutes to complete the test.

Problem 1 (35 points)
For the circuit in the next figure, sketch $v_{01}(t)$.



Using $v_{01}(t)$ as your input voltage for the next circuit, sketch the output voltage $v_0(t)$ considering that at the initial time $t=0$, $v_0(t=0) = 0$

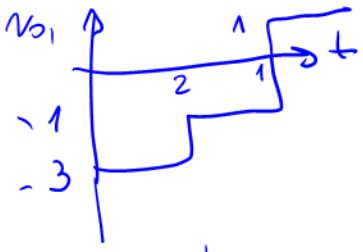


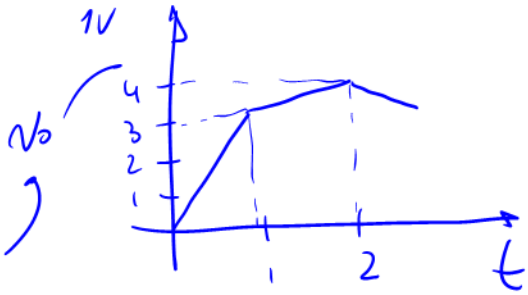
- Top circuit: Difference Amplifier

$$v_{o1} = \frac{R_2}{R_1}\,\frac{\left(1+\frac{R_1}{R_2}\right)}{\left(1+\frac{R_3}{R_4}\right)}\,v_{i2} - \frac{R_2}{R_1}\,v_{i1}$$

curve given above

Since all Resistors are equal then $v_{o1} = \underbrace{v_{i2}}_{1V} - v_{i1}$





The second circuit is an integrator. So,

$$v_o = \begin{cases} -\frac{1}{RC}\int_0^t (-3)\,dt = -(-3)t = 3t & \text{for } 0 \le t < 1 \\ -\frac{1}{RC}\int_1^t (-1)\,dt + v_o(t=1) = -\int_1^t (-1)\,dt + 3 = t - 1 + 3 = t+2 & \text{for } 1 \le t < 2 \\ -\frac{1}{RC}\int_2^t (1)\,dt + v_o(t=2) = -t + 2 + 4 = -t+6 & \text{for } 2 \le t < \infty \end{cases}$$

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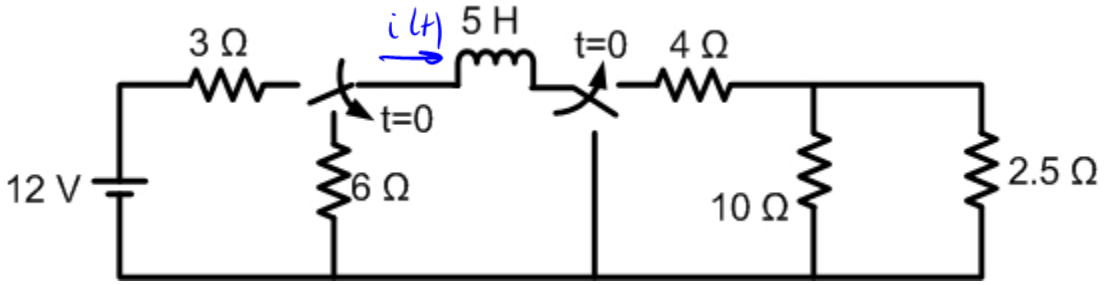
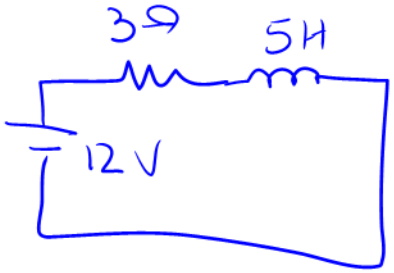
Problem 2 (30 points)

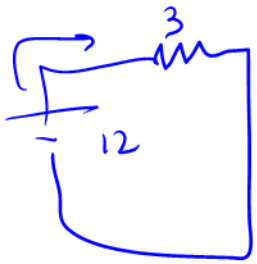
Find out the equation for i(t) with $t \geq 0$ for the circuit in the next figure. Notice that the two switches move at the same time.



For $t=0^-$

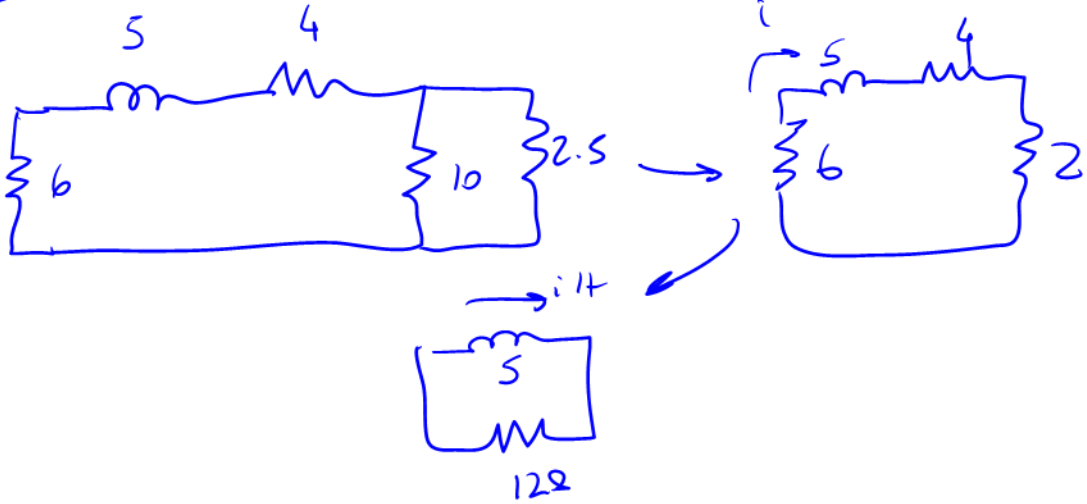


The inductor is a short circuit



$i_L(0) = \frac{12}{3} = 4A = I_0$

For $t=0^+$



$i(t) = I_0 e^{-t/\tau} = 4e^{-2.4t}$

$\tau = \frac{L}{R} = \frac{5}{12} = 2.4$

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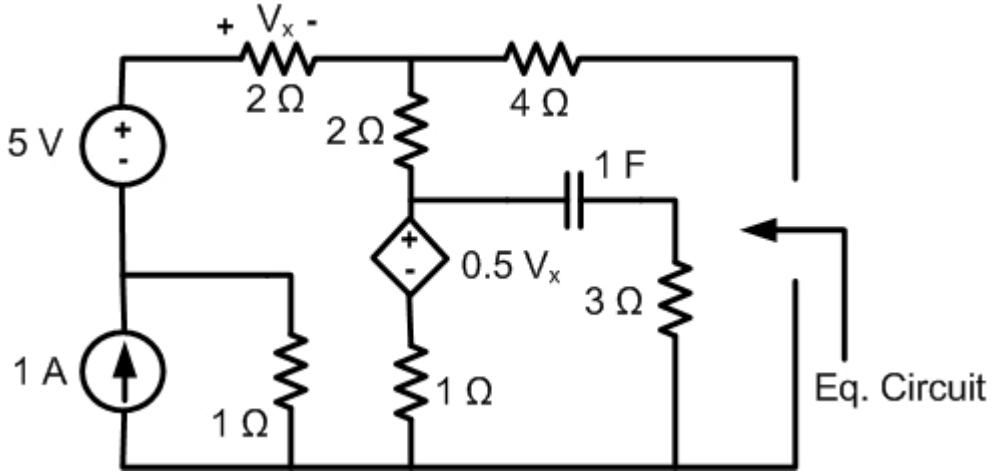
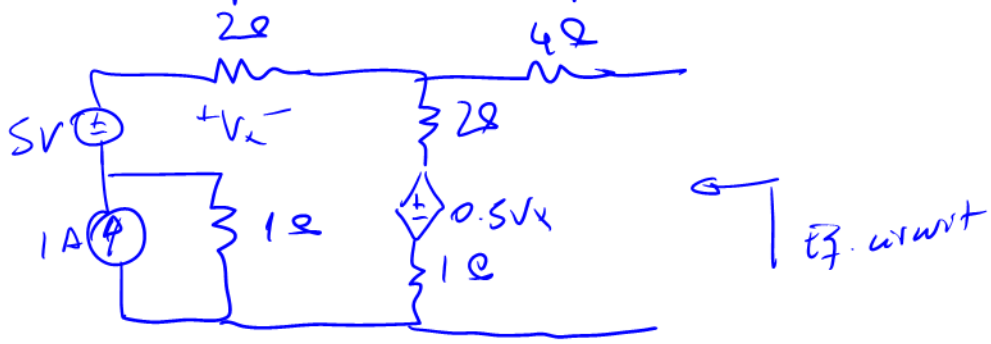
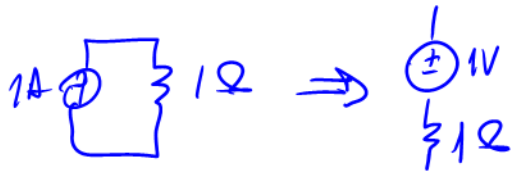
Problem 3 (35 points)

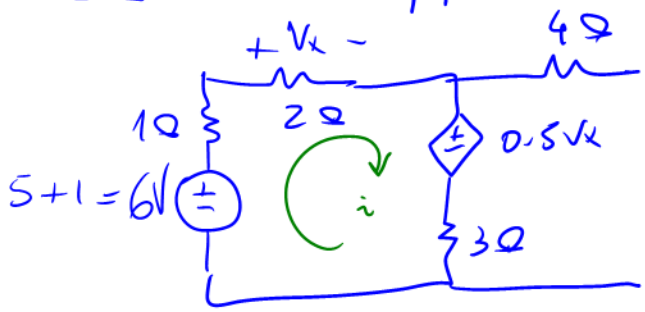
Find the Thevenin and Norton equivalents for the dc circuit in the next figure.



with dc the capacitor is an open circuit. Hence,





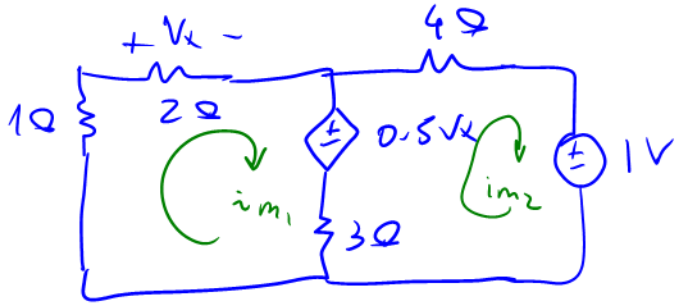


$V_o = 0.5V_x + 3i$

$6 = 1.i + \underbrace{2.i}_{V_x} + 3.i + 0.5.\underbrace{2i}_{V_x}$

$6 = 7i \rightarrow i = \frac{6}{7} = 0.857\,A$

Hence $V_o = 0.5.2.i + 3i = 4i \cong 3.43\,V$



#1 $1 i_{m_1} - 2 i_{m_1} - 0.5(2 i_{m_1}) - 3(i_{m_1} - i_{m_2}) = 0$

($V_x = 2 i_{m_1}$)

$-7 i_{m_1} + 3 i_{m_2} = 0 \longrightarrow 7 i_{m_1} - 3 i_{m_2} = 0$

#2 $-3(i_{m_2} - i_{m_1}) + 0.5(2 i_{m_1}) - 4 i_{m_2} - 1 = 0$

$-7 i_{m_2} + 4 i_{m_1} - 1 = 0$

$\hookrightarrow -4 i_{m_1} + 7 i_{m_2} = -1$

$$\begin{cases} 7 i_{m_1} - 3 i_{m_2} = 6 \\ -4 i_{m_1} + 7 i_{m_2} = -1 \end{cases}$$

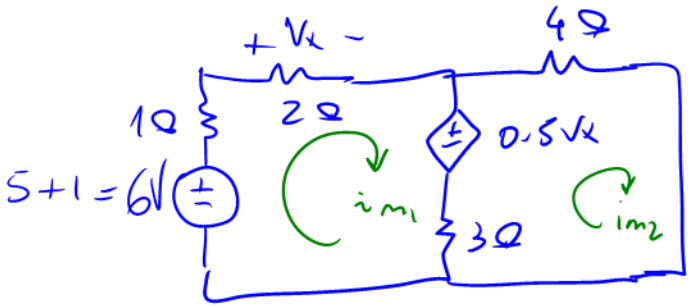
$$i_{m_2} = \frac{\begin{vmatrix} 7 & 0 \\ -4 & -1 \end{vmatrix}}{\begin{vmatrix} 7 & -3 \\ -4 & 7 \end{vmatrix}} = \frac{-7}{49 - 12} = \frac{-7}{37} = 0.189$$

$i_o = -i_{m_2} = 0.189$

$R_{TH} = R_N = \frac{V_o}{i_o} = \frac{1}{0.189} \cong 5.28$

$I_N = \frac{3.43}{5.28} = 0.648$

Norton — Sanity check



$i_{sc} = I_N$

#1 → $7i_{m_1} - 3i_{m_2} = 6$

#2 → $-3(i_{m_2} - i_{m_1}) + 0.5(2i_{m_1}) - 4i_{m_2} = 0$

$-4i_{m_1} + 7i_{m_2} = 0$

$\rightarrow i_{m_1} = \frac{7}{4} i_{m_2}$

$\frac{49}{4} i_{m_2} - 3i_{m_2} = 6$

$37 i_{m_2} = 24$

$i_{sc} = i_{m_2} = \frac{24}{37} = 0.648\,A$