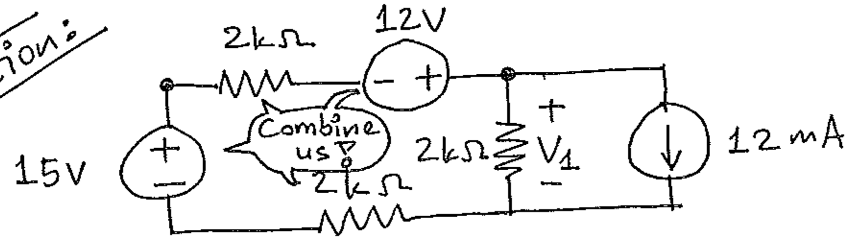
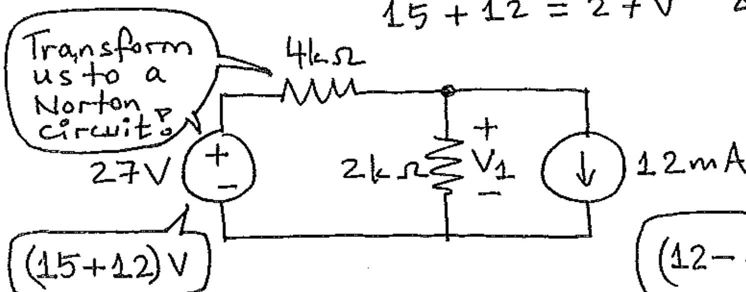
11/05/2011

EE 261 – FALL 2011 – SOLUTIONS TO MIDTERM #2

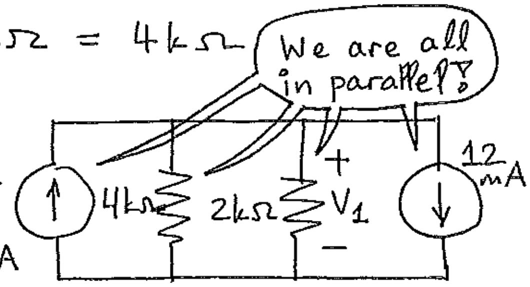
#1 Using source transformation:



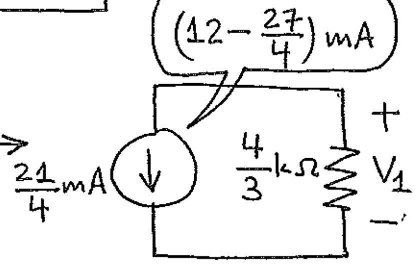
$15 + 12 = 27\,V$ & $2k\Omega + 2k\Omega = 4k\Omega$



Thevenin → to Norton!



→



$$\therefore V_1 = -\left(\frac{4}{3}k\Omega\right)\left(\frac{21}{4}mA\right) = \boxed{-7V}$$

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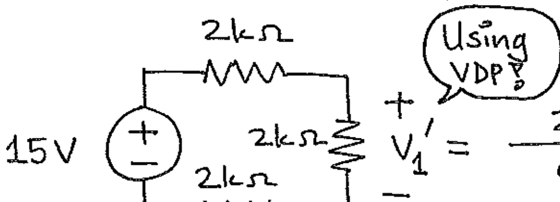
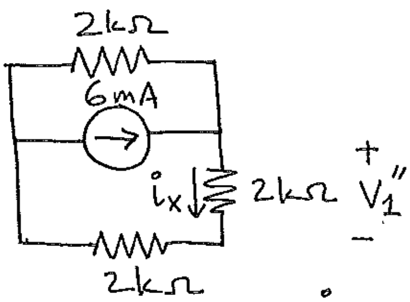
#1 Second approach: Superposition principle:

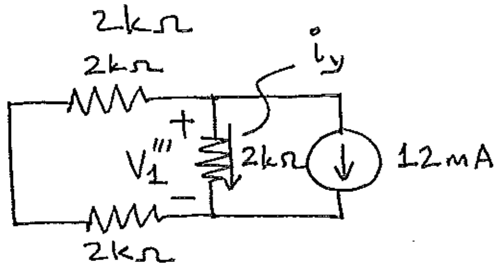


$$V_1' = \frac{2k\Omega}{6k\Omega}(15V) = \boxed{5V}$$



Using CDP: $i_x = \frac{2k\Omega}{6k\Omega}(6mA) = 2mA$ (I'm the other resistor!)

$$\therefore V_1'' = (2k\Omega)(2mA) = \boxed{4V}$$



CDP: $i_y = -\frac{4k\Omega}{6k\Omega}(12mA) = -8mA$ (2kΩ+2kΩ!)

$$\therefore V_1''' = -(2k\Omega)(8mA) = \boxed{-16V}$$

$$\therefore V_1 = V_1' + V_1'' + V_1''' = 5 + 4 - 16 = \boxed{-7V}$$

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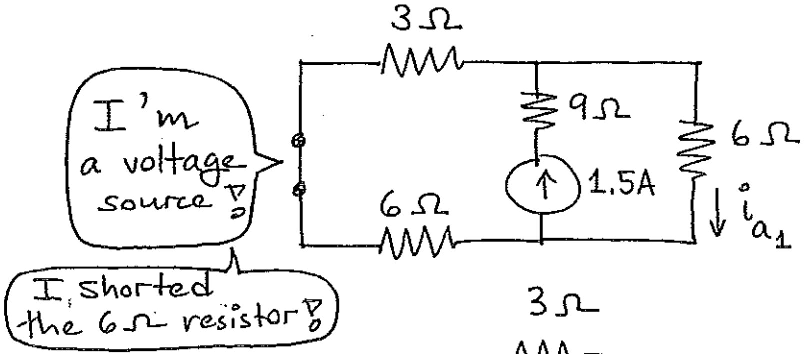
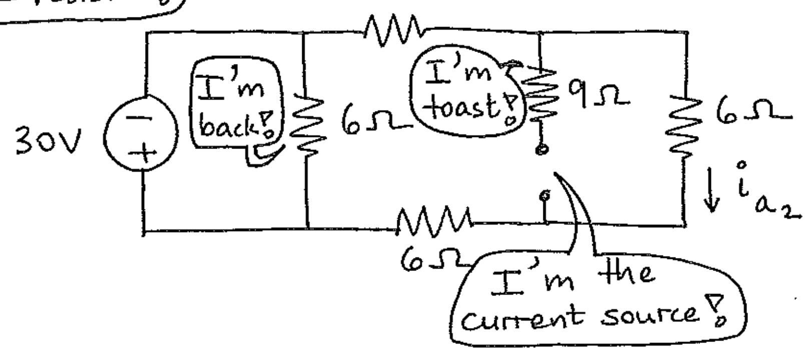
#2 Using superposition principle:

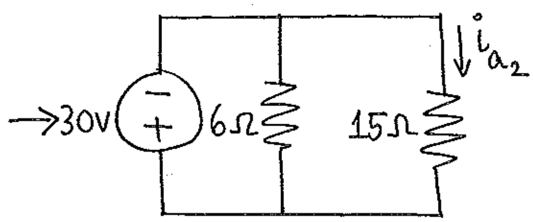


Using CDP:

$$i_{a_1} = \frac{(3+6)}{(3+6)+6}(1.5A)$$

$$= \boxed{0.9A}$$





$$\therefore i_{a_2} = -\frac{30V}{15\Omega} = \boxed{-2A}$$

$$\therefore = i_a = i_{a_1} + i_{a_2} = 0.9 - 2$$

$$= \boxed{-1.1A}$$

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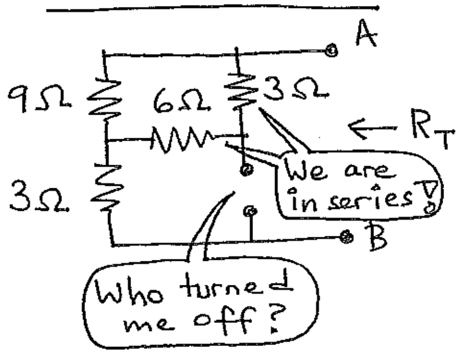
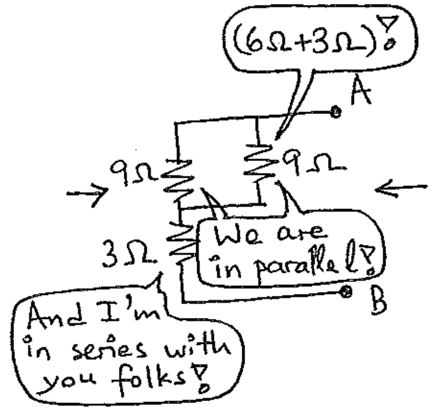
#3 Find the Thevenin equivalent circuit:

To find R_T:



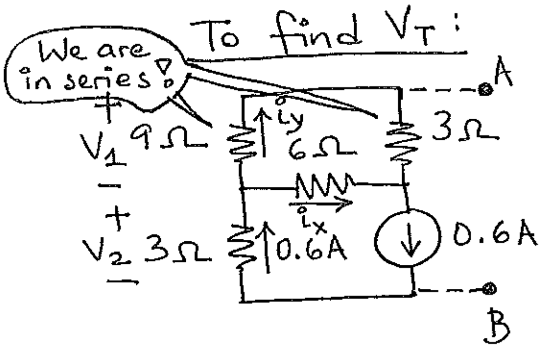


$$R_T = \underbrace{(9 /\!/ 9)}_{4.5} + 3 = \boxed{7.5\Omega}$$

$$\therefore R_L = R_T = \boxed{7.5\Omega}$$

I must equal to R_T to receive max power!

To find V_T:



Between A-B terminals!

$$V_T = V_{oc} = V_1 + V_2$$

The other resistor!

$$\text{CDP: } i_y = \frac{6}{6+12}(0.6) = 0.2A \rightarrow i_x = 0.6 - i_y = 0.4A$$

We are both in Amperes!

$$\therefore V_T = -(9\Omega)(0.2) - (3\Omega)(0.6) = \boxed{-3.6V}$$

$$\therefore P_{L_{max}} = \frac{V_T^2}{4R_T} = \frac{(3.6)^2}{4(7.5)} = \boxed{0.432W}$$

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#4

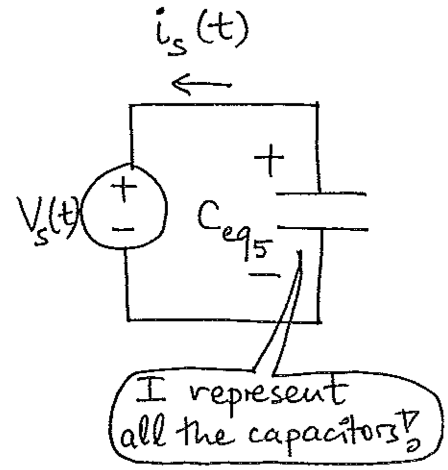
$$C_{eq_1} = C /\!/ C = \frac{(C)(C)}{C+C} = \frac{C}{2}$$

$$C_{eq_2} = C_{eq_1} + C = \frac{3C}{2}$$

$$C_{eq_3} = C_{eq_2} /\!/ C = \frac{(3\cancel{C}/\cancel{2})(C)}{5\cancel{C}/\cancel{2}} = \frac{3C}{5}$$

$$C_{eq_4} = C_{eq_3} + C = \frac{8C}{5}$$

$$C_{eq_5} = C_{eq_4} /\!/ C = \frac{(8\cancel{C}/\cancel{5})(C)}{(13\cancel{C}/\cancel{5})} = \boxed{\frac{8C}{13}}$$



$$i_s(t) = -C_{eq_5}\frac{dV_s(t)}{dt}$$

$$\rightarrow 4\cancel{\sin(2.6\times10^{6}t)}\times10^{-3} = -\left(\frac{8C}{\cancel{13}}\right)\left[-\overset{0.2}{\cancel{2.6}}\times10^{7}\,\cancel{\sin(2.6\times10^{6}t)}\right]$$

$$\rightarrow C = \frac{4\times10^{-3}}{8\times0.2\times10^{7}} = 2.5\times10^{-10}\,F = \boxed{0.25\,nF}$$