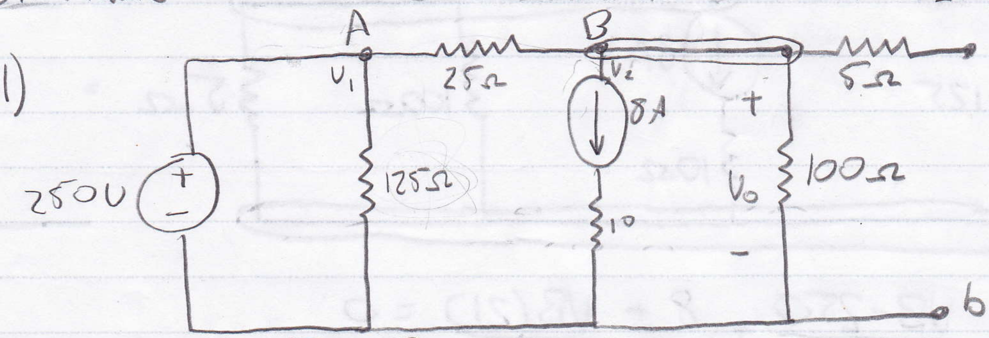
Brian Faure 150003563 PEE Hw #6 Due 10/27/2014

#1)



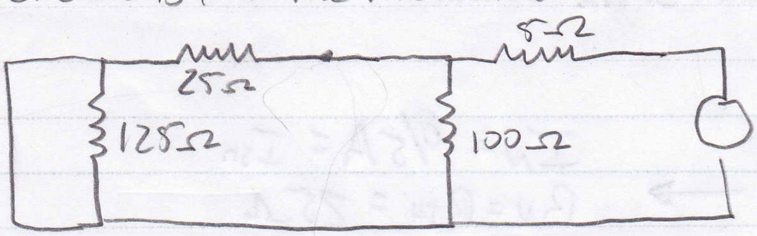
a.) $\underline{V_A = 250}$ $\quad \frac{V_B - 250}{25} + 8 + \frac{V_B}{100} = 0$

$\frac{4V_B}{100} + \frac{V_B}{100} - 10 + 8 = 0 \quad \frac{5V_B}{100} = 2 \quad V_B = \frac{200}{5} \quad V_B = 40$

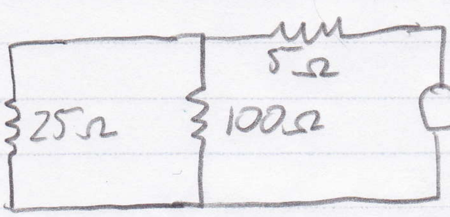
$V_o = V_B - 0 = V_B$ ✱✱

$\boxed{V_o = 40\text{ volts}}$ (Short circuit current is written after part B, sorry I missed the question) ✱✱

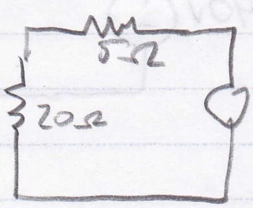
b.) You turn all voltage sources into shorts & all current sources into open circuits to find the thevenin resistance...



-Next step is to replace the 125Ω resistor because all current will travel through the short



$\left(\frac{4}{100} + \frac{1}{100}\right)^{-1} = 20\Omega$



$20 + 5 = \boxed{25\Omega = R_{eq}}$

✱ a. cont.) Short circuit current, short the a & b nodes and solve for current through wire

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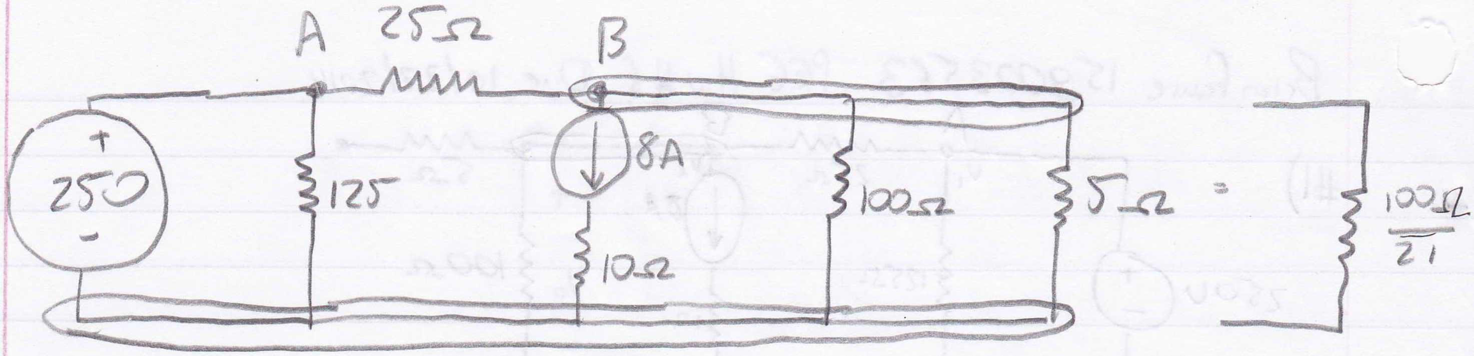
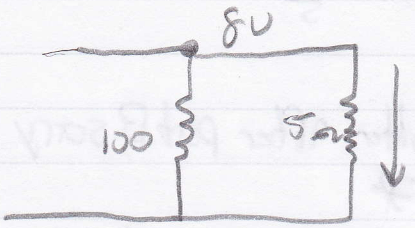
→

$$100\Omega \parallel 5\Omega = \left(\frac{1}{100} + \frac{20}{100}\right)^{-1} = \frac{100}{21}\Omega$$



$V_A = 250\,V$ $\qquad \dfrac{V_B - 250}{25} + 8 + \dfrac{V_B(21)}{100} = 0$

$\dfrac{25V_B}{100} = 2 \qquad 25V_B = 200 \qquad V_B = 8$

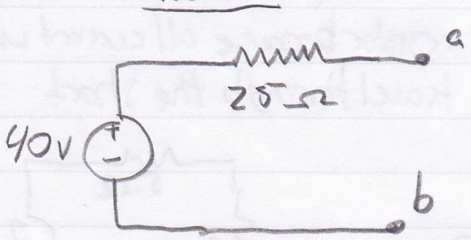


$V = 8V$

$I = \boxed{8/5\,A}$

c.) Draw the norton equivalent of the circuit

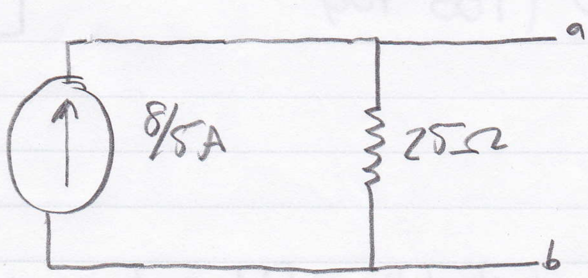
Thevenin



$\longrightarrow$ $I_N = 8/5\,A = I_{sh}$

$R_N = R_{TH} = 25\Omega$

Norton



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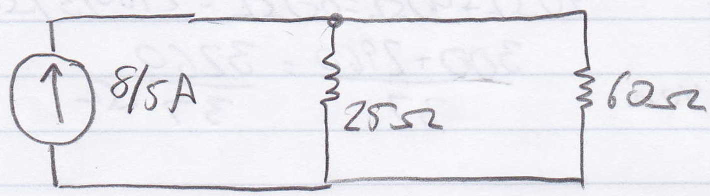
d.) If load 60Ω connected to norton eq. what is the power delivered to the load? Explain

$P = V^2/R = I^2 R$



Current divider

$\left(\frac{25}{85}\right)\left(\frac{8}{5}\right) = I$

$I = \frac{40}{85}A = \frac{8}{17}A \quad P = (I^2)(R) = \left(\frac{64}{289}\right)(60) = \frac{3840}{60}$

$\boxed{P = \frac{3840}{289} \text{ watts}}$ (Took current divider then used I^2R to achieve answer)

e.) The power consumed by the 25Ω resistor would be...

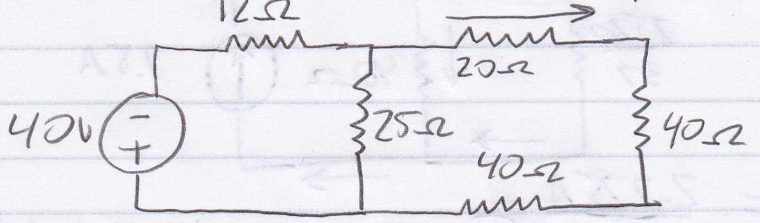
Current Divider

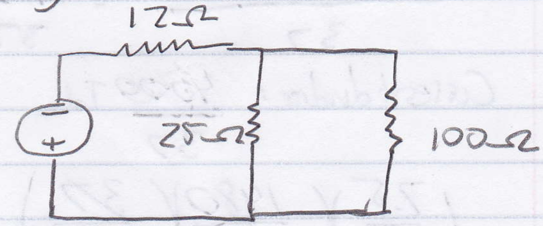
$\left(\frac{60}{85}\right)\left(\frac{8}{5}\right) = I \quad I = \frac{96}{85} A \quad P = \left(\frac{9216}{7225}\right)(25)$

$\boxed{P = \frac{230400}{7225} \text{ Watts} \approx 31.889}$

#2) Use superposition to find the current through 20Ω resistor...

Case One (only 40V source)





$\left(\frac{1}{25} + \frac{1}{100}\right)^{-1} = 20\Omega$

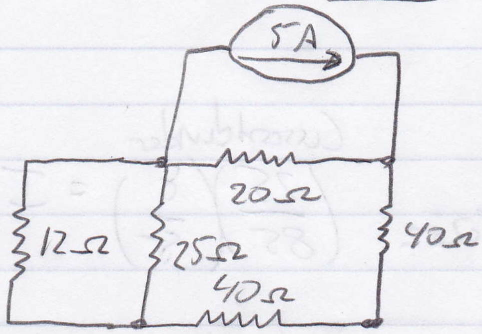
Req = 32Ω

$I_{in} = 40/32\,A = 5/4\,A$

Current Divider → $\left(\frac{5}{4}\right)\left(\frac{25}{125}\right) = 1/4\,A$ [Case one : 1/4 A (left to right)]

Case one: 1/4 A →

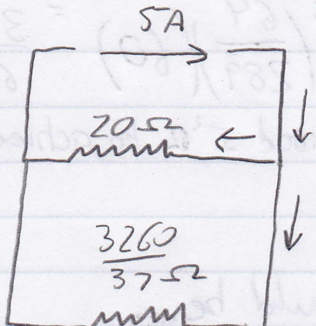
Case Two (only 5A source)



$$\left(\tfrac{1}{12}+\tfrac{1}{25}\right)^{-1} = 300/37\,\Omega$$

$$40\Omega + 40\Omega = 80\Omega = 2960/37\,\Omega$$

$$\frac{300+2960}{37} = \frac{3260}{37}\,\Omega$$



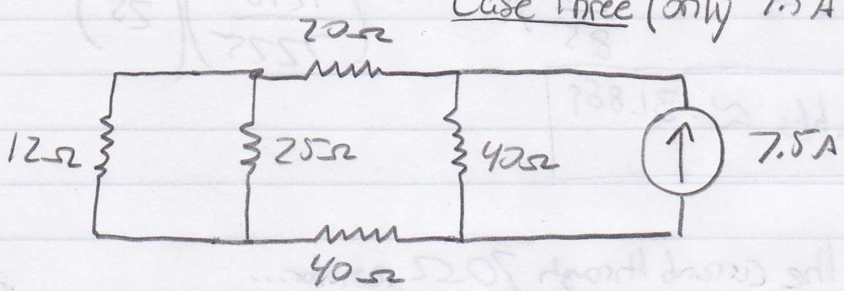
Current divider: $20 = \frac{740}{37} \,//\, \frac{740+3260}{37}$

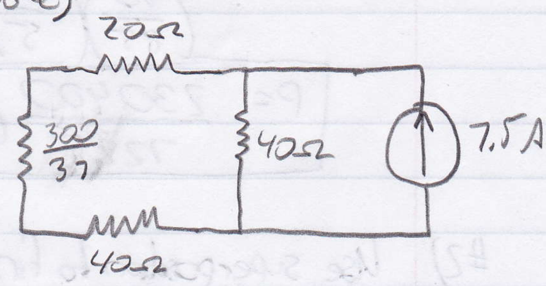
$$= \frac{4000}{37} \rightarrow \left(\frac{5A}{1}\right)\left(\frac{3260}{37}\cdot\frac{37}{4000}\right)$$

$$= \frac{5}{1}\cdot\frac{3260}{4000} = 4.075A$$

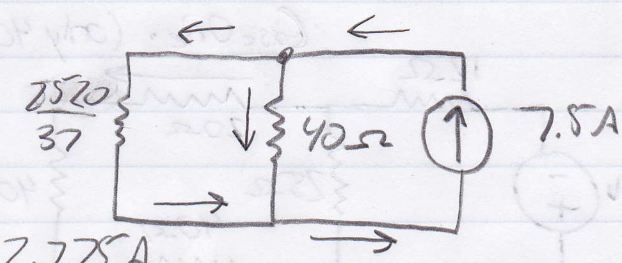
[Case Two: 4.075A (to the left)] ←

Case Three (only 7.5A source)





$$\frac{300+740+1480}{37} = \frac{2520}{37}$$



Current divider: $\frac{4000}{37}$ Tot

$$\left(\frac{7.5}{1}\right)\left(\frac{1480}{37}\right)\left(\frac{37}{4000}\right) = 2.775A$$

[Case Three 2.775A (to the left)]

- Tot. Current in 20Ω resistor = $-0.25 + 2.775 + 4.075 = 6.6A$

$\boxed{6.6A}$

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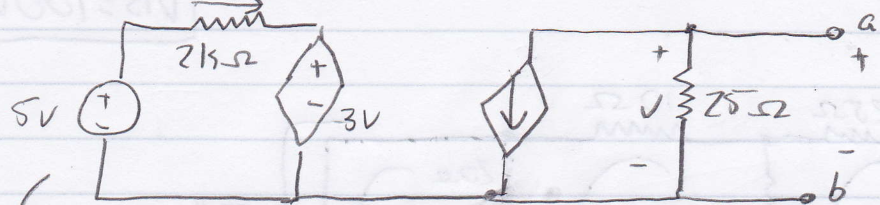
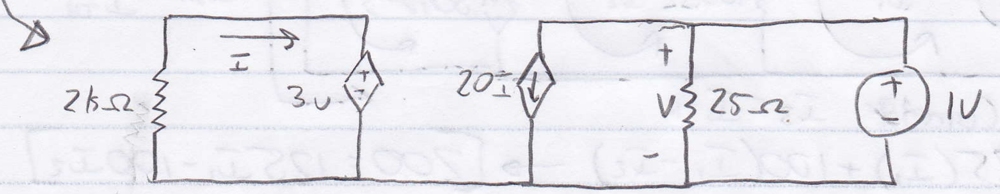
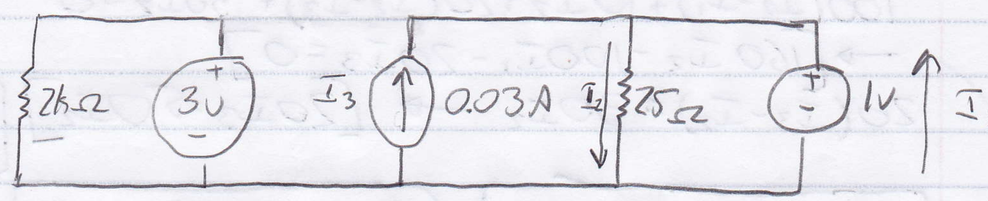
#3) Find Req directly for following circuit





$V = 1\text{ Volt}$

$I = \dfrac{-3}{2000}$

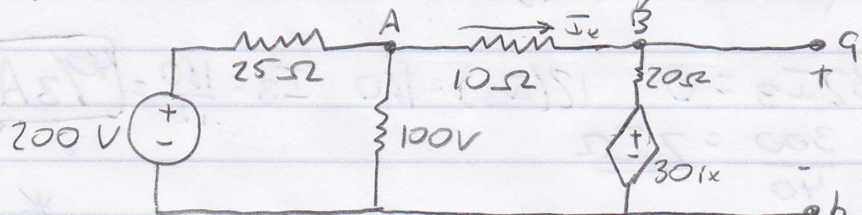


$I_2 = 1/25 = 0.04A$

$I_3 = 0.03A$ $\qquad I_1 = I_2 - I_3 = 0.04 - 0.03 = 0.01A = I_1$

$R_{TH} = 1V/0.01A = \boxed{100\Omega = R_{TH}} = R_{eq}$

#4) Need to model the power consumed by resistor load as a function



Finding V_{TH}: $VB = V_{OC} = V_{TH}$

$\dfrac{VA-200}{25} + \dfrac{VA}{100} + \dfrac{VA-VB}{10} = 0 \quad \left[\dfrac{15VA}{100} = 8 + \dfrac{VB}{10}\right]$

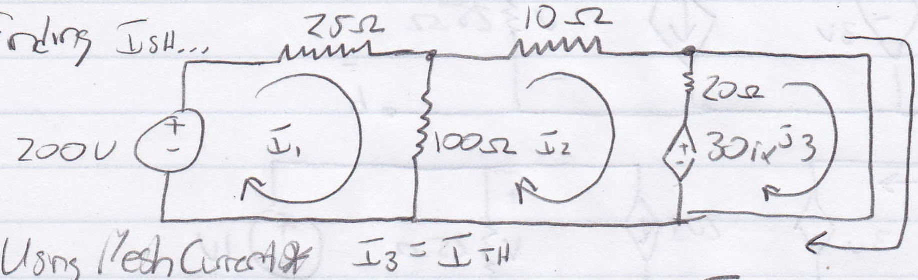
$\dfrac{VB-VA}{10} + \dfrac{VB-30ix}{20} = 0 \quad I_x = \dfrac{VA-VB}{10} \quad \left[\dfrac{3VB}{20} - \dfrac{VA}{10} - \dfrac{30VA}{200} + \dfrac{30VB}{200} = 0\right]$

$\dfrac{60VB}{200} = \dfrac{50VA}{200} \quad 60VB = 50VA \quad \boxed{VA = \dfrac{60VB}{50}} \quad \boxed{VB = \dfrac{50VA}{60}}$

- Plugging that into initial eq... $\frac{90V_A - 80V_A}{600} = 8$ $\frac{40V_A}{600} = 8$ $\boxed{V_A = 120V}$

$\boxed{V_{TH} = V_B = 100V}$ $\boxed{V_B = 100V}$

- Finding I_{SH}...



$I_{SH} = I_{TH}$

* Using Mesh Current Ø $I_3 = I_{TH}$

$200 = 25(I_1) + 100(I_1 - I_2) \rightarrow \boxed{200 = 125I_1 - 100I_2}$

$100(I_2 - I_1) + 10I_2 + 20(I_2 - I_3) + 30I_2 = 0$

$\rightarrow \boxed{160I_2 - 100I_1 - 20I_3 = 0}$

$20(I_3 - I_2) = 30I_2 \rightarrow \boxed{20I_3 = 50I_2}$ $\boxed{I_3 = \frac{50I_2}{20}}$ $\boxed{I_2 = \frac{20I_3}{50}}$

$\boxed{I_1 = \frac{200 + 100I_2}{125}}$ $\boxed{I_2 = \frac{125I_1 - 200}{100}}$

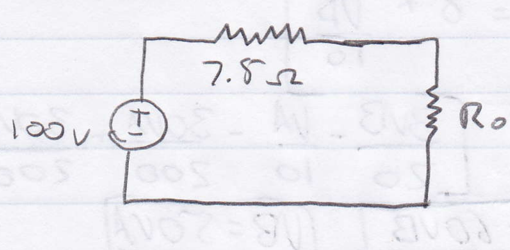
$I_1 = \frac{200}{125} + \frac{100(20I_3)}{50(125)} = \boxed{I_1 = 1.6 + 0.32I_3}$

$\frac{(160)(20)(I_3)}{50} - 100(1.6 + 0.32I_3) - 20I_3 = 0$

$44I_3 - 160 - 32I_3 = 0$ $12(I_3) = 160$ $I_3 = \frac{160}{12} = \boxed{40/3A} = I_3$

$R_{TH} = \frac{100}{1} \cdot \frac{3}{40} = \frac{300}{40} = \underline{7.5\Omega}$

Final Circuit



$I = \frac{100}{7.5 + R_o}$ $P = I^2R$ $\boxed{P(R_o) = \left(\frac{100}{7.5 + R_o}\right)^2 (R_o)}$ *