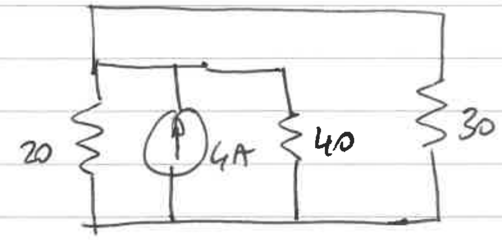
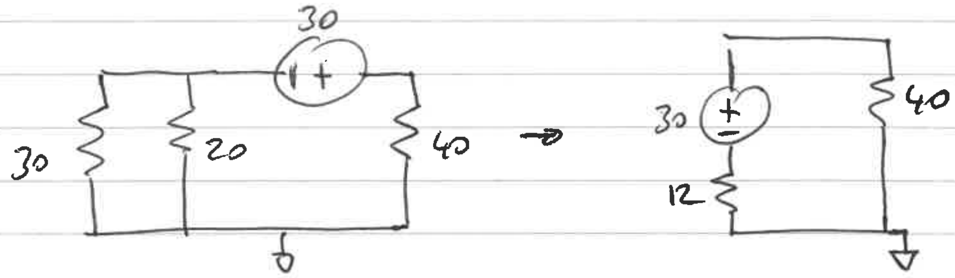
ENSC 3021 2019 TUTORIAL Questions 1A.

Q1 use superposition to find voltage across Resistor

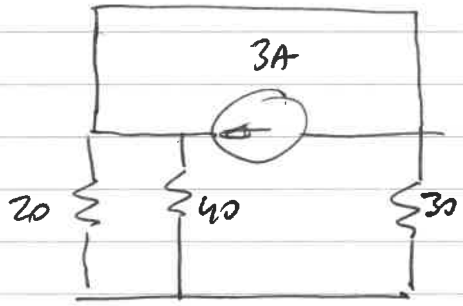
Power $= P = VI = V^2/R$.



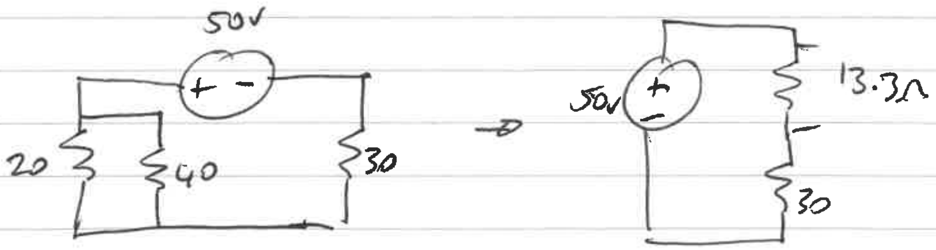
$\underline{V_{1a} = 36.923V.}$



$\underline{V_{1b} = 23.077\ V}$



$\underline{V_{1C} = 0V}$ as current source is shorted.



$\underline{V_{1D} = 15.385V}$

$V_1 = V_{1a} + V_{1b} + V_{1C} + V_{1D} = 75.385$

Power $= 75.385^2/40 = \underline{142 \text{ watts}}$

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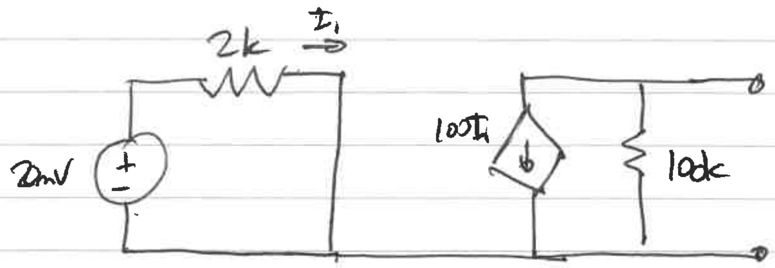
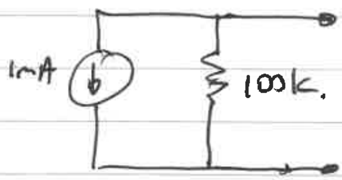
Q2

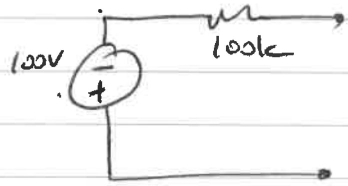


$$I_1 = \frac{20mV}{2k} = 10\mu A. \quad \Rightarrow \quad 100 I_1 = 1mA$$

So Norton equivalent :



Thevenin equivalent :



Note the open circuit voltage will be −100V, and resistance looking in 100k when independent sources removed as $I_1 = 0$ in that case.

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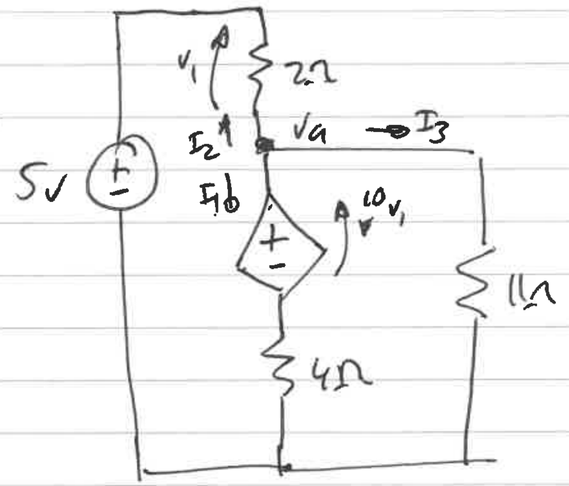
Q3. Use superposition again, with nodal analysis at each node to solve for the voltage.

Step 1 Just the voltage source



note $v_1 = 5 - V_a$.

$I_1 + I_2 + I_3 = 0$

$I_3 = \frac{V_a}{11}$ $\quad I_2 = \frac{V_a - 5}{2}$

to find I_1 go around the loop on the left with KVL

$5 = 11V_1 + 4I_1$ $\quad V_1 = 5 - V_a$

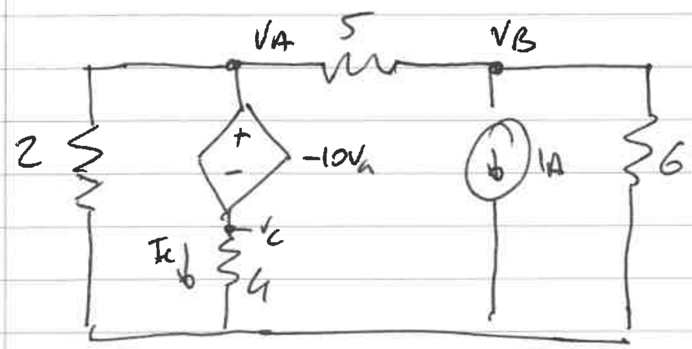
$5 = 11(5 - V_a) + 4I_1$

$I_1 = \frac{1}{4}(11V_a - 50)$

$$\frac{V_a}{11} + \frac{V_a - 5}{2} + \frac{1}{4}(11V_a - 50) = 0$$

$\Rightarrow \underline{\underline{V_{a_1} = 4.48979\,v}}$

Step 2 Just the current source.



KCL at node B:

$\frac{V_B - V_A}{5} + 1 + \frac{V_B}{6} = 0$ ①

KCL at node A:

$\frac{V_a}{2} + \frac{V_a - V_B}{5} + I_c = 0$

$I_c = V_c/4$, KVL around left loop gives $V_c = 11V_a$

$\Rightarrow \left(\frac{1}{2} + \frac{1}{5} + \frac{11}{4}\right)V_a = \frac{V_B}{5}$. ②

Solving ① + ② gives $V_{a_2} = -0.1633\,v$

$V_a = V_{a_1} + V_{a_2} = 4.327v \Rightarrow \boxed{V_1 = 5 - 4.327 = 0.673V}$

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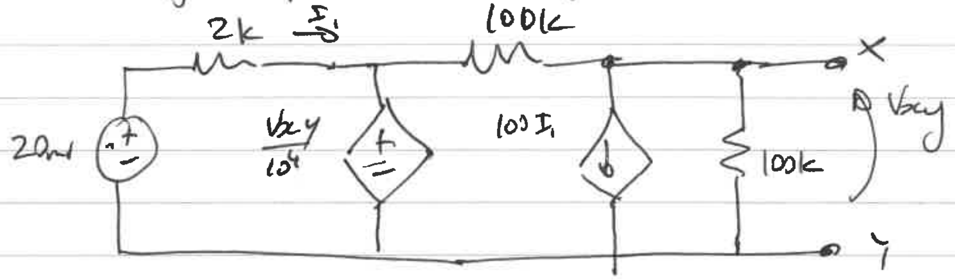
Q4. First find open circuit voltage



$$i_1 = \frac{20mV - \frac{V_{xy}}{10^4}}{2k}$$

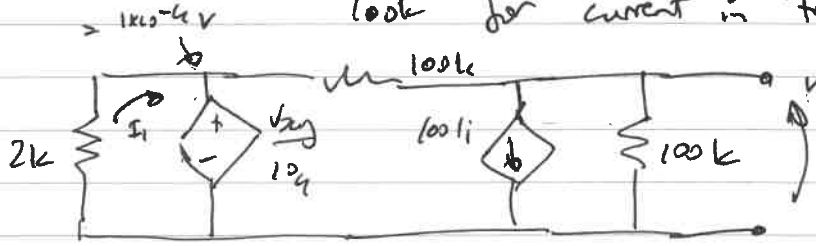
KCL at node x: $100 i_1 + \frac{V_{xy}}{10^5} + \frac{V_{xy} - \frac{V_{xy}}{10^4}}{10^5} = 0$

$$\frac{1.9999\,V_{xy}}{10^5} + \frac{100}{2000}\left(20\times10^{-3} - \frac{V_{xy}}{10^4}\right) = 0$$

$\Rightarrow \boxed{V_{xy} = -66.67V}$

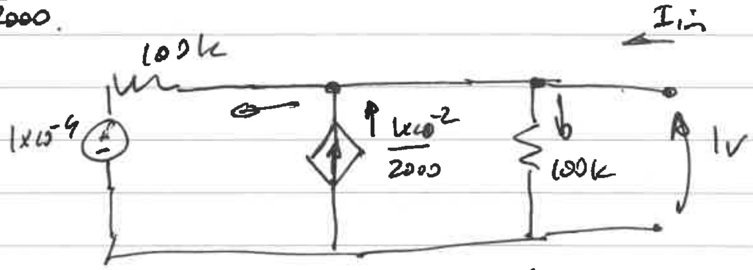
~~Now current in with independent~~

Now equivalent resistance looking in when independent source removed: - Apply a test voltage of 1V @ xy and look for current in to find resistance:



$V_{xy} = \underline{1V}$ test voltage

$$I_1 = -\frac{1\times10^{-4}}{2000}.$$



KCL @ node x: $\frac{1\times10^{-2}}{2000} - \frac{1-1\times10^{-4}}{10^5} - \frac{1}{10^5} + i_{in} = 0$

$5\mu A - 10\mu A - 10\mu A + i_{in} = 0 \Rightarrow i_{in} = 15\mu A.$

$R_{th} = \frac{1V}{15\mu A} = \boxed{66.67\,k\Omega}$

$\boxed{V_{th} = -66.67V}$