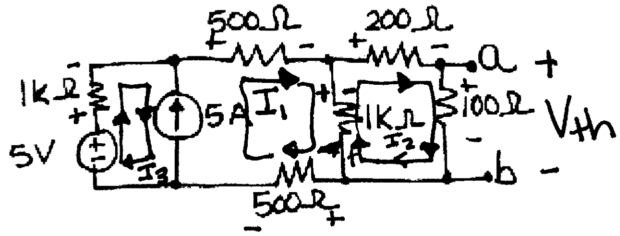
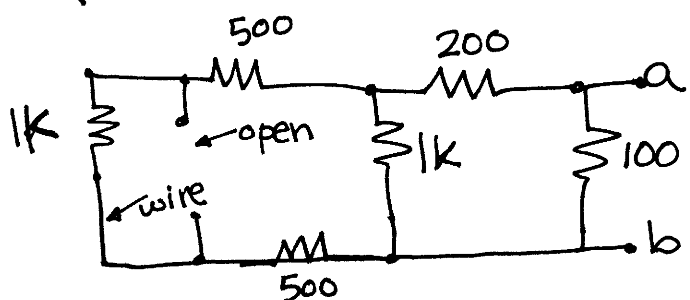
1. Find the Thevenin equivalent circuit between terminals a-b.



$V_{th} = 100 \cdot I_2$

· Circuit contains only independent source.

(Short all independent sources: (V=0) becomes wire
(I=0) becomes open)



$$R_{th} = 100 \,||\, [200 + \underbrace{2k||1k}_{\frac{2k(1k)}{3k}}] = 100||867 = \frac{100(867)}{967} \cong 89.6\,\Omega$$

Using mesh current method:

① $+5 - I_3(1k) - 500I_1 - 200I_2 - 100I_2 - 500I_1 = 0$

② $5A = I_1 - I_3 \rightarrow I_3 = I_1 - 5A$

③ $+5 - I_3(1k) - 500I_1 - 1kI_1 + 1kI_2 - 500I_1 = 0$

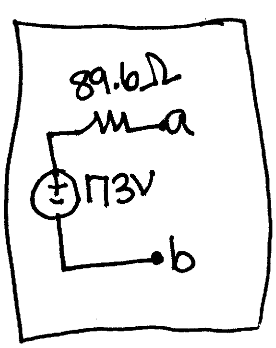
④ $+1k(I_1) - 1k(I_2) - 200I_2 - 100I_2 = 0 \rightarrow$ $I_2 = \frac{1kI_1}{1.3k}$

use ②,④ & plug into ③

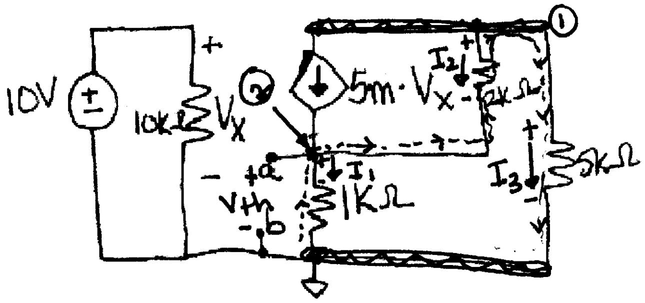
$+5 - 1k(I_1 - 5) - 500I_1 - 1.5kI_1 + 1k\left(\frac{1kI_1}{1.3k}\right) = 0$

$I_1\left(1k + 500 + 1.5k - \frac{1k}{1.3}\right) = 5 + 5k \rightarrow I_1 = 2.24$

$\therefore I_2 = 2.24\left(\frac{1}{1.3}\right) = 1.73 \rightarrow V_{th} = 173V$



2. Find the Thevenin equivalent circuit between terminals a-b.



$V_x = 10V$

$V_{th} = I_1 (1k)$

V-loop: $+I_1(1K) + I_2(2k) - I_3(5K) = 0$

at ① ΣI: $+5m(10) + I_2 + I_3 = 0 \rightarrow I_3 = -I_2 - 50m$

at ② ΣI: $-5m(10) + I_1 - I_2 = 0 \rightarrow I_1 = I_2 + 50m$

$1K(I_2 + 50m) + 2K(I_2) - 5K(-I_2 - 50m) = 0$

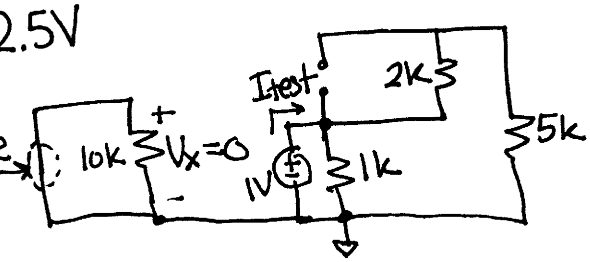
$I_2(1k + 2K + 5K) = -1k(50m) - 5k(50m)$

$I_2(8K) = -50 - 250 = -\frac{300}{8K} = -37.5mA$

$I_1 = -37.5m + 50m = +12.5mA$

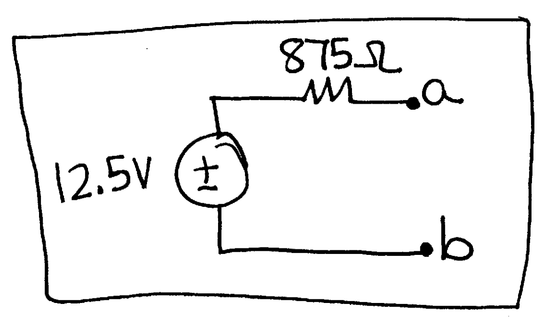
$V_{th} = 12.5m(1k) = 12.5V$

Using a test source:

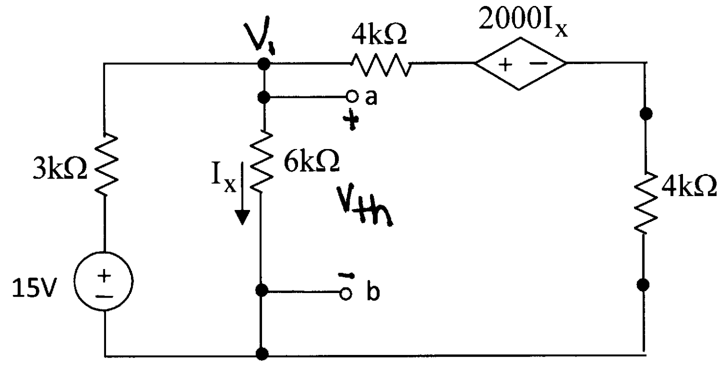


$I_{test} = \frac{1}{1k \| 7k}$

$R_{th} = 1k \| 7k = \frac{1k(7k)}{8k} = 875\Omega$



3. Determine the Thevenin equivalent circuit between terminals a-b.

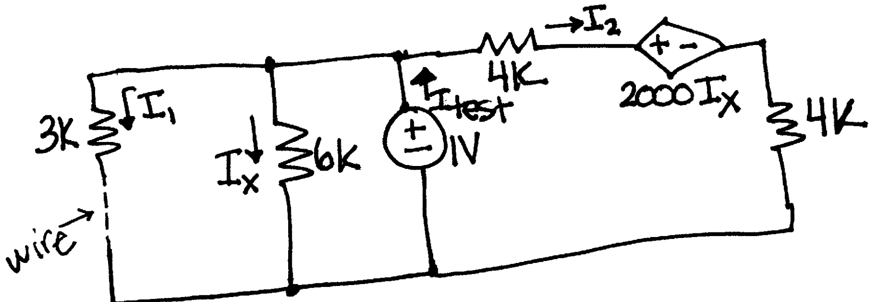


$V_1 = V_{th}$

$$\frac{(V_1-15)}{3K} + \frac{V_1}{6K} + \frac{V_1 - 2000\left(\frac{V_1}{6K}\right)}{8K} = 0$$

$$V_1\left(\frac{1}{3k} + \frac{1}{6k} + \frac{1}{8K} - \frac{2K}{6K \cdot 8K}\right) = \frac{+15}{3K}$$

where $V_1 = \frac{15}{3K(5.833\times10^{-4})} = 8.57V$

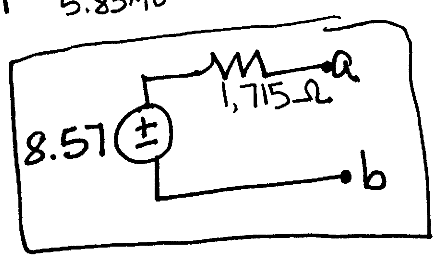


$I_X = \frac{1}{6K}$

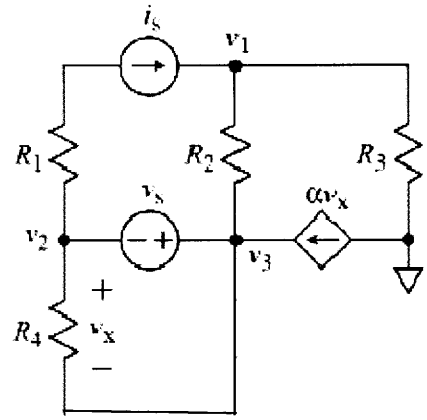
$$+\frac{(1\ )}{3K} + \frac{1}{6K} - I_{test} + \frac{(1-2000(\frac{1}{6K}))}{8K} = 0$$

$I_{test} = 3.33\times10^{-4} + 1.667\times10^{-4} + 8.33\times10^{-5} = 5.83\times10^{-4}$

$R_{th} = \frac{1}{5.83\times10^{-4}} = 1{,}715$



4. For the circuit shown, write three independent equations for the node voltages v_1, v_2, and v_3. The quantity V_x must not appear in the equations.



5. Solve the equations in Problem 4 to find v_1, v_2, and v_3

6. From Problem 4, calculate the power in the dependent source. State whether it is consuming or producing power.

① $-i_s + \frac{(V_2-V_3)}{R_2} + \frac{V_1}{R_3} = 0$

② $\cancel{\frac{(V_2-V_3)}{R_4}} + i_s + \frac{(V_3-V_1)}{R_2} + \cancel{\frac{(V_3-V_2)}{R_4}} - \alpha(V_2-V_3) = 0$

$V_s = V_3 - V_2 \rightarrow V_2 = V_3 - V_s$

② $+i_s + \frac{(V_3-V_1)}{R_2} - \alpha(-V_s) = 0$

$V_1 = i_s R_2 + \alpha V_s R_2 + V_3$

plug into ①

$-i_s + \frac{(\cancel{V_3} - V_s - \cancel{V_3})}{R_2} + \frac{(i_s R_2 + \alpha V_s R_2 + V_3)}{R_3} = 0$

$\boxed{V_3 = i_s R_3 + \frac{V_s R_3}{R_2} - i_s R_2 - \alpha V_s R_2}$

$\boxed{V_1 = i_s R_3 + \frac{V_s R_3}{R_2}}$ $\boxed{V_2 = i_s R_3 + \frac{V_s R_3}{R_2} - i_s R_2 - \alpha V_s R_2 - V_s}$

#6 power is $\alpha V_x(-V_3)$

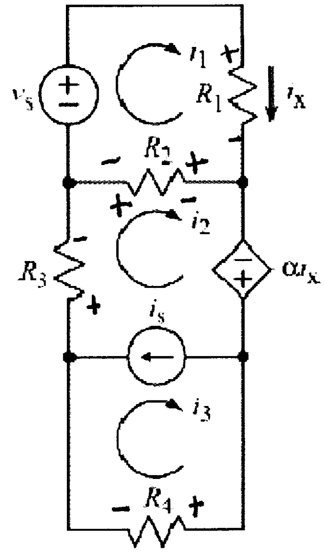
$V_x = -V_s$

$$\boxed{\text{power} = \alpha(-V_s)\left[i_s R_3 + \frac{V_s R_3}{R_2} - i_s R_2 - \alpha V_s R_2\right]}$$

if $\left[i_s R_3 + \frac{V_s R_3}{R_2} - i_s R_2 - \alpha V_s R_2\right] > 0$ then it is producing

if $\left[i_s R_3 + \frac{V_s R_3}{R_2} - i_s R_2 - \alpha V_s R_2\right] < 0$ then it is consuming

7. For the circuit shown, write three independent equations for the three mesh currents, i_1, i_2, and i_3. The quantity i_x must not appear in the equations.



8. Solve the equations in Problem 7 to find i_1, i_2, and i_3.

$$i_x = i_1$$

$$i_s = (i_2 - i_3) \rightarrow i_3 = (i_s + i_2)$$

$$+V_s - i_1 R_1 + R_2(i_2 - i_1) = 0 \rightarrow i_1 \cancel{(R_1+R_2)} = \frac{i_2 R_2 + V_s}{(R_1+R_2)}$$

$$-R_4(i_3) - R_3(i_2) + R_2(i_1 - i_2) + \alpha i_1 = 0$$

$$-R_4(i_2 - i_s) - i_2 R_3 + R_2\left(\frac{i_2 R_2 + V_s}{(R_1+R_2)}\right) - i_2 R_2 + \frac{\alpha(i_2 R_2 + V_s)}{(R_1+R_2)} = 0$$

$$i_2\left(R_4 + R_3 - \frac{R_2 \cdot R_2}{(R_1+R_2)} + R_2 - \frac{\alpha R_2}{(R_1+R_2)}\right) = +i_s R_4 + \frac{V_s R_2}{(R_1+R_2)} + \frac{\alpha V_s}{(R_1+R_2)}$$

$$i_2 = \underbrace{\frac{i_s R_4 (R_1+R_2) + V_s(R_2 + \alpha)}{\cancel{R_1+R_2}} \cdot \frac{\cancel{(R_1+R_2)}}{(R_2+R_3+R_4)(R_1+R_2) - R_2 R_2 - \alpha R_2}}$$

$$i_3 = (\quad) - i_s$$

#8. (cont.)

$$i_1 = \frac{V_s}{(R_1+R_2)} + \frac{R_2}{(R_1+R_2)} \cdot \frac{i_s R_4 (R_1+R_2) + V_s (R_2+\alpha)}{\left[(R_2+R_3+R_4)(R_1+R_2) - R_2(R_2+\alpha)\right]}$$