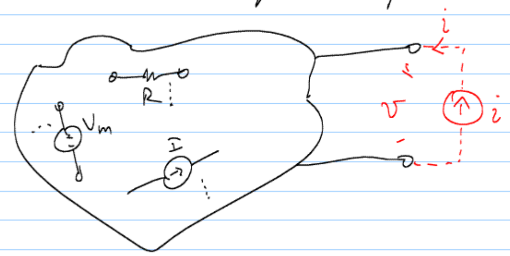
INEL 3105 Lecture #6.

Note Title 8/27/2009

Another circuit analysis technique: Thevenin



By superposition, the "form" of the answer is:

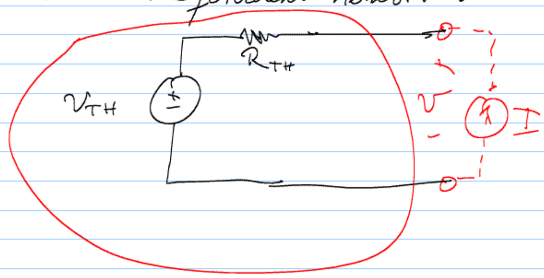
$$v = \sum_m \alpha_m V_m + \sum_n \beta_n I_n + R i$$

- $\sum_m \alpha_m V_m$: by making all current sources zero,
- $\sum_n \beta_n I_n$: by making all voltage sources zero
- $R i$: my i source

$$v_{TH} + R i$$

$v = v_{TH} + R i$

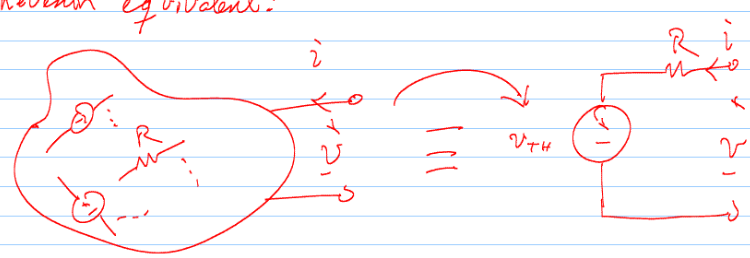
Thévenin equivalent network:



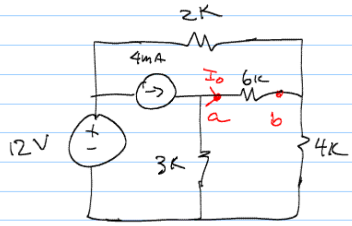
v_{TH} → Open circuit voltage at port

R_{TH} → Resistance "seen" at port.

Thévenin equivalent:

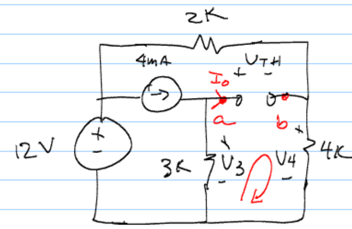


Ejemplo:



Evalúe el eq. de Thévenin entre "a" y "b" y encuentre I_o.

Step 1: Abrir el terminal en cuestión:



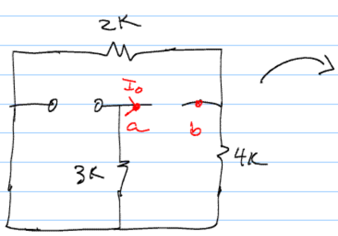
Step 2: Evaluar V_{TH}

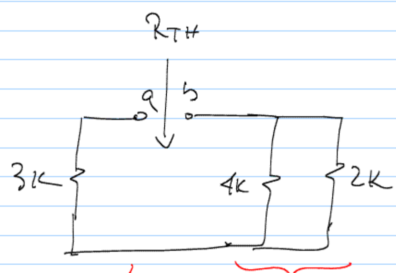
KVL @ (loop) : $V_3 - V_{TH} - V_4 = 0$; $V_3 = 4mA(3k) = 12V$

$V_4 = 12\left(\frac{4k}{6k}\right) = 8V$

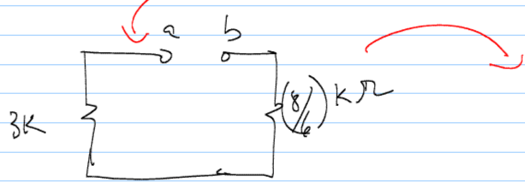
$V_{TH} = V_3 - V_4 = 4V$

Step 3: Evaluar R_{TH}

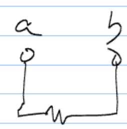




en paralelo

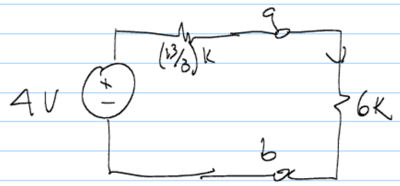


en serie



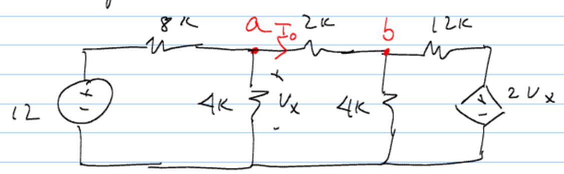
$R_{TH} = 3k + \left(\frac{8}{6}\right)k = \left(\frac{13}{3}\right)k\Omega$

Step 4: Remplazar circuito y escribir el equivalente de thévenin.

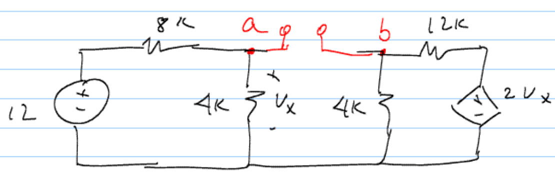


$$I_o = \frac{4}{6k + \frac{13}{3}} = \frac{12}{31}\ mA$$

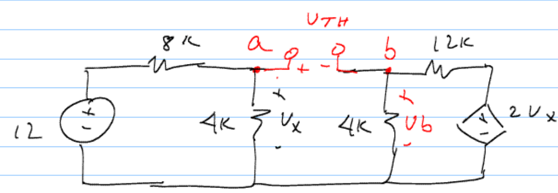
Otro ejemplo: Evalúe el equivalente de Thevenin entre "a" y "b" y luego calcule Io



Step 1: abrir los terminales en cuestión.



Step 2: Evaluar V_{TH}



$V_x = V_a$

$V_{TH} - V_a + V_b = 0$

$V_{TH} = V_a - V_b$

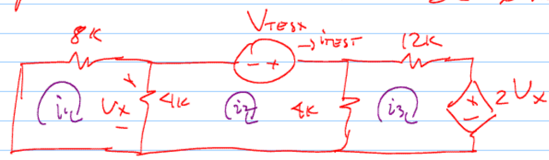
Divisor de voltaje:

$$V_a = 12\left(\frac{4k}{12k}\right) = 4V$$

$$V_b = 2V_x\left(\frac{4k}{16k}\right) = \frac{V_a}{2} = 2V$$

$$V_{TH} = 4V - 2V = 2V$$

Step 3: Evaluar R_{TH} : Se eliminan las fuentes indep.



$$R_{TH} = \frac{V_{TEST}}{I_{TEST}}$$

Análisis por mallas:

KVL @ (i_1) : $8K\, i_1 - 4K\,(i_1 - i_2) = 0$

KVL @ (i_2) : $4K\,(i_1 - i_2) + V_{TEST} - 4K\,(i_2 - i_3) = 0$

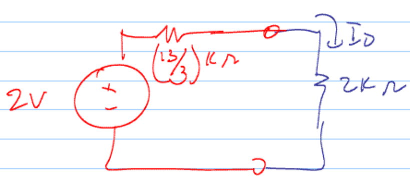
KVL @ (i_3) ; $4K\,(i_2 - i_3) - 12K\, i_3 - 2\left(4K\,(i_1 - i_2)\right) = 0$

Ecuaciones auxiliares: $i_{TEST} = i_2$;

Procedimiento para continuar: despeje KCL @ (i_1) para $i_2\,(i_1)$ =
despeje KCL @ (i_3) para $i_3\,(i_2)$
Sustituya $i_2(i_1)$
$i_3(i_2)$ en KCL @ (i_2)

Despeje para $\frac{V_{TEST}}{I_{TEST}} = R_{TH} = \left(\frac{13}{3}\right) k\Omega$

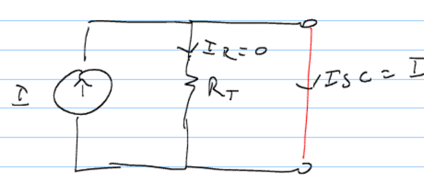
Step 4: Remplazar el circuito y escribir el equivalente de Thevenin.



$$I_o = \frac{2}{\frac{13}{3}k\Omega + 2k\Omega} = \frac{6}{19}\ mA.$$

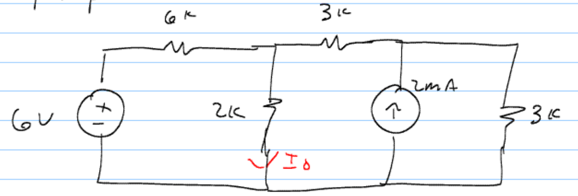
Equivalente de Norton:

Equivalente Thevenin



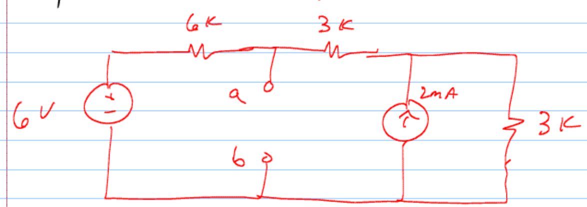
Equivalente de Norton

Ejemplo:

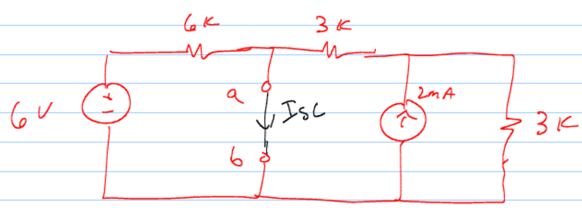


Evalúe Io por medio de equivalente de Norton.

Step 1: Se abren los terminales en cuestión



Step 2: Se coloca un corto circuito y se calcula I_{sc}



Análisis por superposición:

1) Apagando la fuente de voltaje, y haciendo divisor de corriente

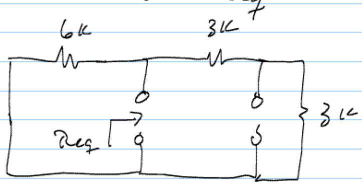
$$I_{sc}' = 2mA\left(\frac{3k}{6k}\right) = 1mA$$

2) Apagando la fuente de corriente

$$I_{sc}'' = \frac{6V}{6k} = 1mA$$

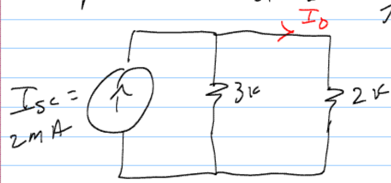
3) $I_{sc} = I_{sc}' + I_{sc}'' = 2mA$

Step 3: Evaluar Req:



$$R_{eq} = 6k // 6k = 3k$$

Step 3: Escribir el equivalente de Norton:



Por divisor de corriente:

$$I_o = 2mA\left(\frac{3k}{5k}\right) = \left(\frac{6}{5}\right) mA$$