Heimadæmi 4 - Lausnir 15/02/21

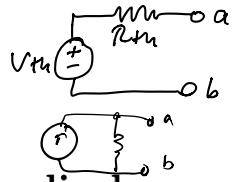
Gott að muna:
1. $G = 1/R$
2. núllstillum línulir

Skrefin eru alltaf þau sömu:

(1) Finna tómagangsspennu $V_{oc} = V_{th}$ (2) Finna skammhlaupsstraum I_{sc}

(3) Núllstilla óháðar línulir, setja 1A „prufustraum" á milli a & b, þá er $R_{eq} = V$ [Ω] spennan yfir straumlindina.

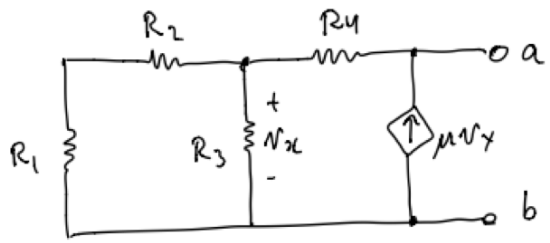
(4) Teiknum Thévenin jafngildisrás & Norton



$$I_N = \frac{V_{th}}{R_{th}} = \frac{V_{th}}{R_{eq}}$$

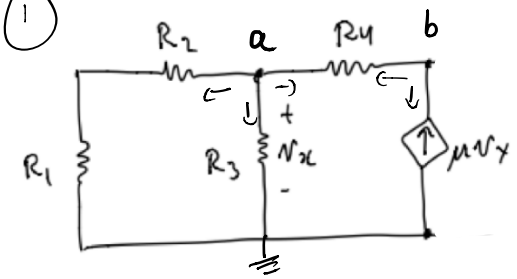
Dæmi 1 – Spennustýrð straumlind

Hint: Hér er háð lind, þá verðið þið að setja inn 1 A prufustraum og finna spennu yfir straumlind til að meta jafngildisviðnámið.



Breyta	Gildi
μ	$2\,\mho$
R_1	$30\,\Omega$
R_2	$20\,\Omega$
R_3	$4\,\Omega$
R_4	$5\,\Omega$

(1)



Hér $R = R_1 + R_2$ & $V_x = V_a$

KCL í a $\quad G(V_a - 0) + G_3 V_a + G_4 (V_a - V_b) = 0$

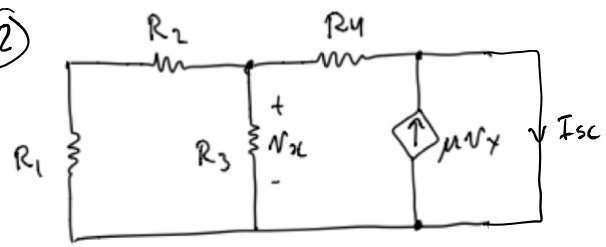
KCL í b $\quad G_4 (V_b - V_a) - \mu V_a = 0$

$$\begin{bmatrix} G+G_3+G_4 & -G_4 \\ -G_4-\mu & G_4 \end{bmatrix} \begin{bmatrix} V_a \\ V_b \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \qquad \begin{bmatrix} V_a \\ V_b \end{bmatrix} = \begin{bmatrix} 0V \\ 0V \end{bmatrix}$$

Hér er engin óháð lind (input)

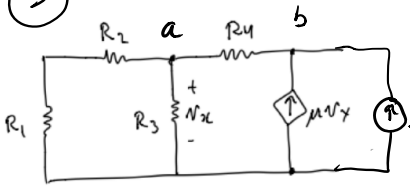
svo $\underline{V_{oc} = V_b = 0\,V}$

(2)



Hið sama gildir hér $\underline{I_{sc} = 0\,A}$

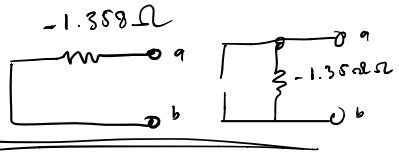
(3)



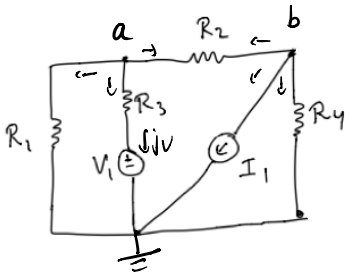
$$+ \begin{bmatrix} G+G_3+G_4 & -G_4 \\ -G_4-\mu & G_4 \end{bmatrix} \begin{bmatrix} V_a \\ V_b \end{bmatrix} = \begin{bmatrix} 1A \\ 0 \end{bmatrix}$$

þá er $\underline{R_{eq} = V_b\,\Omega \approx -1.358\,\Omega}$

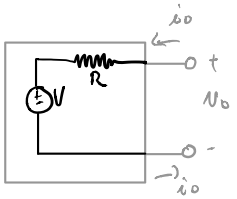
(4)



Dæmi 2 – Óháðar lindir



Breyta	Gildi
V_1	2 V
I_1	2 mA
R_1, R_3	1 kΩ
R_2	2 kΩ
R_4	0.5 kΩ



"Resistive voltage source"
Ein rásaeining

i_o er óþekkt

en $N_o = V + i_o R$

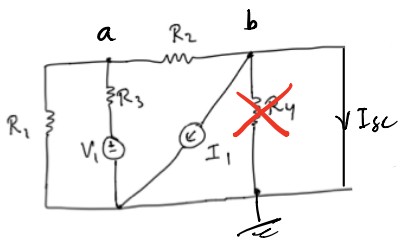
↑

sett inn í MNRA

① Hef $N_{jöfnur} = N_{hnútp.} + N_{spennulindir} - 1 = 3 + 1 - 1 = 3$

$$\begin{bmatrix} G_1+G_2 & -G_2 & 1 \\ -G_2 & G_2+G_4 & 0 \\ 1 & 0 & -R_3 \end{bmatrix} \begin{bmatrix} N_a \\ N_b \\ jV \end{bmatrix} = \begin{bmatrix} 0 \\ -I_1 \\ V_1 \end{bmatrix} \quad \text{svo} \quad \begin{bmatrix} N_a \\ N_b \\ jV \end{bmatrix} = \begin{bmatrix} \frac{2}{3}\,V \\ -\frac{2}{3}\,V \\ -\frac{1}{750}\,A \end{bmatrix}$$

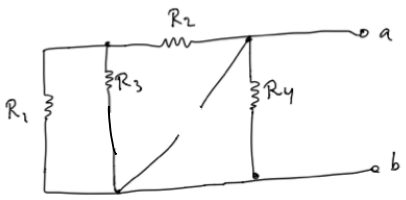
eða $V_{oc} = N_b = -\frac{2}{3}\,V$

② 

$$\begin{bmatrix} G_1+G_2 & -G_2 & 1 & 0 \\ -G_2 & G_2 & 0 & 1 \\ 1 & 0 & -R_3 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} N_a \\ N_b \\ jV \\ I_{sc} \end{bmatrix} = \begin{bmatrix} 0 \\ -I_1 \\ V_1 \\ 0 \end{bmatrix} \quad \begin{bmatrix} N_a \\ N_b \\ jV \\ I_{sc} \end{bmatrix} = \begin{bmatrix} \frac{4}{5}\,V \\ 0\,V \\ -\frac{6}{5}\,mA \\ -\frac{8}{5}\,mA \end{bmatrix}$$

$I_{sc} = -\frac{8}{5}\,mA$

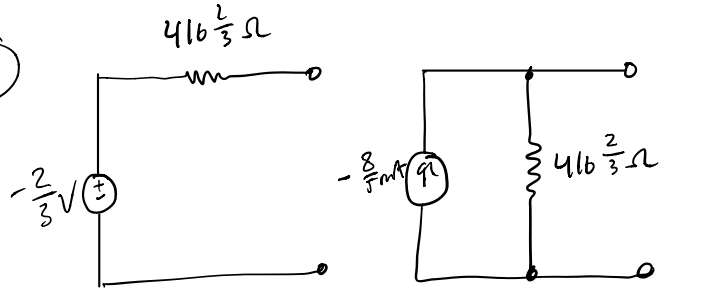
③ Hér eru engir háðir lindir, auðvelt!



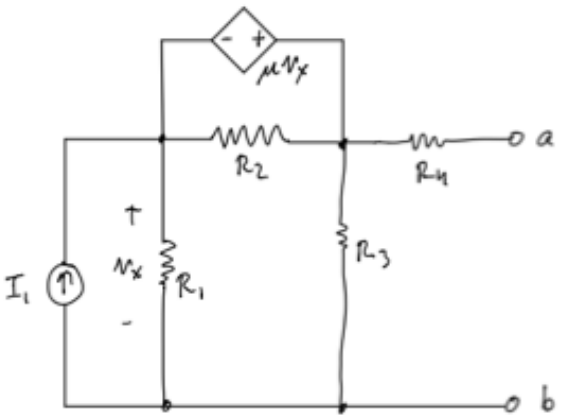
Hér er $R_{eq} = R_4 \,\|\, (R_2 + R_1 \| R_3)$

$= 416\frac{2}{3}\,\Omega$

(Sjáum að $V_{oc} = I_{sc} R_{eq}$ passar!)

④ 

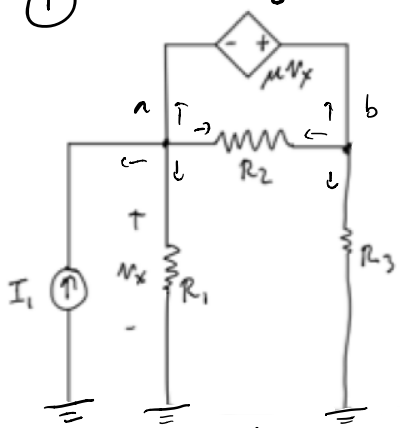
Dæmi 3 – Spennustýrð spennulind



Breyta	Gildi
I_1	5 A
μ	2
R_1	4 Ω
R_2, R_4	2 Ω
R_3	6 Ω

Höfum $N_{jöfn} = N_{mótp} + N_{spennulindir} - 1 = 3 + 1 - 1 = 3$

(1) ← j

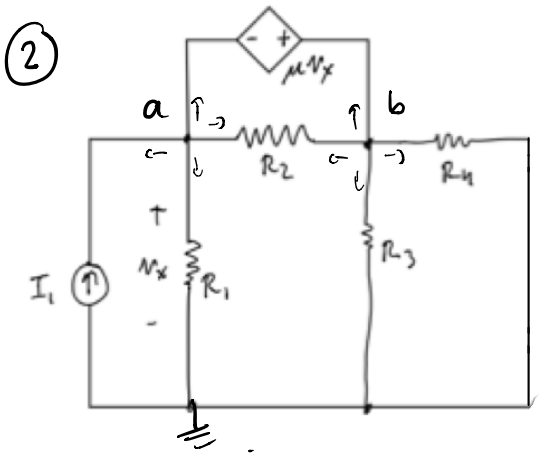


$\mu(V_a - 0) = V_b - V_a$

$$\begin{array}{c} \\ a \\ b \\ VCVS \end{array} \begin{array}{c} \begin{array}{ccc} a & b & VCVS \end{array} \\ \left[\begin{array}{ccc|c} G_1+G_2 & -G_2 & -1 & V_a \\ -G_2 & G_2+G_3 & 1 & V_b \\ \hline -1-\mu & 1 & 0 & j \end{array}\right] \end{array} = \begin{bmatrix} I_1 \\ 0 \\ \hline 0 \end{bmatrix} \quad \text{eða} \quad \begin{bmatrix} V_a \\ V_b \\ \hline j \end{bmatrix} = \begin{bmatrix} \frac{20}{3}\,V \\ 20\,V \\ \hline -10\,A \end{bmatrix}$$

svo $V_{oc} = V_b = 20\,V$

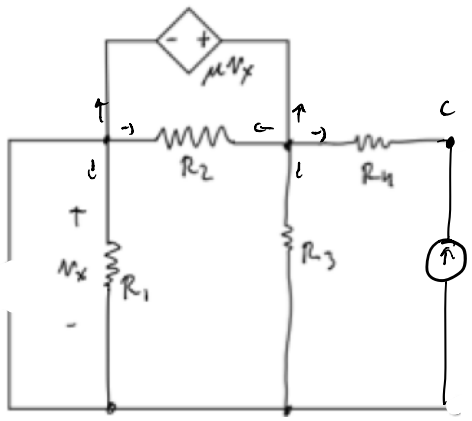
(2)



$$\begin{array}{c} \\ a \\ b \\ VCVS \end{array} \begin{array}{c} \begin{array}{ccc} a & b & VCVS \end{array} \\ \left[\begin{array}{ccc|c} G_1+G_2 & -G_2 & -1 & V_a \\ -G_2 & G_2+G_3+G_4 & 1 & V_b \\ \hline -1-\mu & 1 & 0 & j \end{array}\right] \end{array} = \begin{bmatrix} I_1 \\ 0 \\ \hline 0 \end{bmatrix} \quad \text{eða} \quad \begin{bmatrix} V_a \\ V_b \\ \hline j \end{bmatrix} = \begin{bmatrix} \frac{20}{9}\,V \\ \frac{20}{3}\,V \\ \hline -\frac{20}{3}\,A \end{bmatrix}$$

svo $I_{sc} = \frac{V_b - 0}{R_4} = \frac{10}{3}\,A$

(3)



Hér er $N_{jöfn} = 4$

$$\begin{array}{c} \\ a \\ b \\ c \\ VCVS \end{array} \begin{array}{c} \begin{array}{cccc} a & b & c & VCVS \end{array} \\ \left[\begin{array}{cccc|c} G_1+G_2 & -G_2 & 0 & -1 & V_a \\ -G_2 & G_2+G_3+G_4 & -G_4 & 1 & V_b \\ 0 & -G_4 & G_4 & 0 & V_c \\ \hline -1-\mu & 1 & 0 & 0 & j \end{array}\right] \end{array} = \begin{bmatrix} 0 \\ 0 \\ 1A \\ \hline 0 \end{bmatrix}$$

$R_{eq} = V_c\,\Omega = 6\,\Omega$