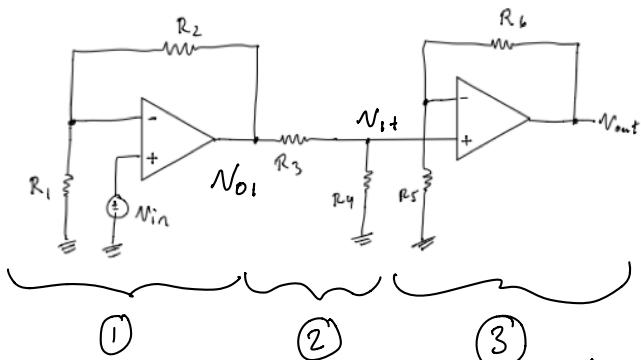


Dæmi 1 – Tveir aðgerðarmagnarar

Finnið hlutfallið $v_{\text{out}}/v_{\text{in}}$ 

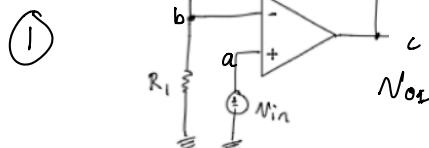
Kjördgjafarmagnir "rættengjars"
virker eins & spennulind
gagnvart rásinni seu fylgj.

Breyta	Gildi
R_1, R_2, R_5, R_6	$10 \text{ k}\Omega$
R_3	$2 \text{ k}\Omega$
R_4	$8 \text{ k}\Omega$

Fyrir kjördgjardarmagnara gildir

$$\bar{V} = V^+ - V^- \quad i^- = i^+ = 0$$

$i_{\text{out}}, V_{\text{out}}$ óþekkta

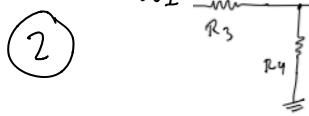


$$\text{Veit } V_a = V_b = V_{\text{in}} \quad (\text{spenndeiling}) \quad R_1$$

$$\text{svo } V_b = V_{01} \frac{R_1 + R_2}{R_1 + R_2}$$

$$\text{ðóða } N_{01} = \frac{R_1 + R_2}{R_1} V_{\text{in}} = 2 V_{\text{in}}$$

N_{01} með spenndeilingar form

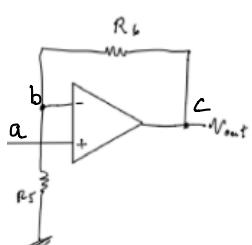


$$N_{1+} = \frac{R_4}{R_3 + R_4} V_{01} = \frac{4}{5} V_{01}$$

$$\text{Hér } V_{1+} = V_a = V_b$$

$$\text{Nú er } V_b = V_{\text{out}} \frac{R_6}{R_5 + R_6} = 2 V_{\text{out}}$$

$$\text{ðóða } V_{1+} = 2 V_{\text{out}}$$



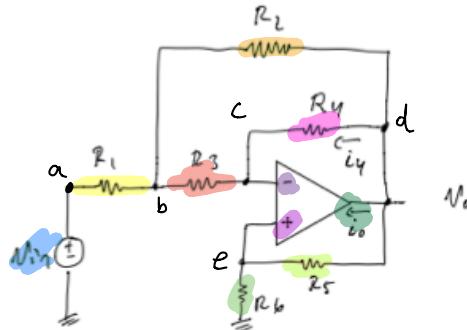
$$\frac{V_{\text{out}}}{V_{\text{in}}} = (2) \left(\frac{4}{5} \right) (2) = \frac{16}{5}$$

(1) (2) (3)

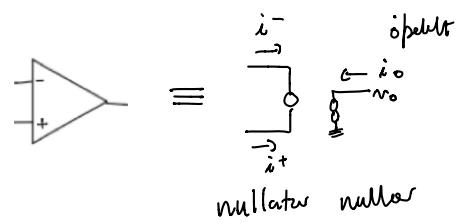
Sætum við allt saman

Dæmi 2 – Thévenin jafngildisrás

Finnið v_o , i_4 og i_o . Finn ið næst Thévenin jafngildisrás séð frá v_{in} . Athugið að spennulindin er ekki tekin með.



Breyta	Gildi
v_{in}	5 V
R_1, R_2, R_6	1 Ω
R_3, R_5	2 Ω
R_4	3 Ω



✓ nullor er eins og spennulindir
med óspenntri spennur (& straum i_o)

$$\text{Hér } N_{jöfnur} = N_{hnitpunktir} + N_{spennulindir} - 1 = 6 + 2 - 1 = \underline{\underline{7 \text{ jöfnur}}}$$

	a	b	c	d	e	V_{in}	nullor				
a	G_1	$-G_1$	0	0	0	1	0	N_a	0	N_a	5 V
b	$-G_1$	$G_1 + G_2 + G_3$	$-G_3$	$-G_2$	0	0	0	N_b	0	N_b	$\frac{5}{13} V$
c	0	$-G_3$	$G_3 + G_4$	$-G_4$	0	0	0	N_c	0	N_c	$-\frac{15}{13} V$
d	0	$-G_2$	$-G_4$	$G_2 + G_4 + G_5$	$-G_5$	0	1	N_d	0	N_d	$-\frac{45}{13} V$
e	0	0	0	$-G_5$	$G_5 + G_6$	0	0	N_e	0	N_e	$-\frac{15}{13} V$
V_{in}	1	0	0	0	0	0	0	jV_{in}	N_{in}	jV_{in}	$\frac{-60}{13} A$
nullor	0	0	-1	0	1	0	0	i_{in}	0	i_{in}	$\frac{75}{13} A$

Athugrjt at i d er KCL $G_2(N_d - N_b) + G_4(N_d - N_c) + G_5(N_d - N_e) + i_o = 0$

straumur ít

¶ $N_e = N_c$ lejör at gerðarmagni

$$N_u' \text{ er } N_o = N_d = \underline{\underline{-\frac{45}{13} V}}$$

$$i_4 = G_4(N_d - N_c) = \frac{1}{3} \left(-\frac{45}{13} - \left(-\frac{15}{13} \right) \right) = \underline{\underline{-\frac{10}{13} A}}$$

$$i_o = \underline{\underline{\frac{75}{13} A}}$$

$$\text{Einung er } \frac{N_{out}}{V_{in}} = \frac{N_d}{N_a} = -\frac{\frac{45}{13}}{5} = -\frac{9}{13}$$

Við fólkum eftir því að engin óhöt línd er í rásinni, svo $V_{Th} = 0V$

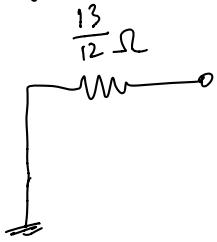
Setjum inn 1A prufströnum í a & málokum spennun, svo

(notum sama MNA fyrir Þ skipum I A óháðni straumleiðinni fyrir N_{12})

$$\begin{array}{c|ccccc}
 & a & b & c & d & e \\
 \hline
 a & G_1 & -G_1 & 0 & 0 & 0 \\
 b & -G_1 & G_1 + G_2 + G_3 & -G_3 & -G_2 & 0 \\
 c & 0 & -G_3 & G_3 + G_4 & -G_4 & 0 \\
 d & 0 & -G_2 & -G_4 & G_2 + G_4 + G_5 & -G_5 \\
 e & 0 & 0 & 0 & -G_5 & G_5 + G_6 \\
 \hline
 \text{nullar} & 0 & 0 & -1 & 0 & 1
 \end{array}
 \quad
 \begin{array}{c|ccccc}
 & 0 & 1 & 0 & 1 & 0 \\
 \hline
 & N_a & N_b & N_c & N_d & N_e \\
 & 0 & 0 & 0 & 0 & 0 \\
 & N_d & N_e & \dots & 0 & N_e \\
 & 0 & i_o & & 0 & i_o \\
 \hline
 & 0 & & & & 0
 \end{array}
 \quad
 \begin{array}{c|ccccc}
 & 1A & 0 & 0 & 0 & 0 \\
 \hline
 & 1A & 0 & 0 & 0 & 0 \\
 & 0 & 0 & 0 & 0 & 0 \\
 & 0 & 0 & 0 & 0 & 0 \\
 & 0 & 0 & 0 & 0 & 0
 \end{array}
 \quad
 \begin{array}{c|ccccc}
 & N_a & N_b & N_c & N_d & N_e \\
 & 0 & 0 & 0 & 0 & 0 \\
 & 0 & 0 & 0 & 0 & 0 \\
 & 0 & 0 & 0 & 0 & 0 \\
 & 0 & 0 & 0 & 0 & 0
 \end{array}
 \quad
 \begin{array}{c|ccccc}
 & \frac{13}{12}V & \frac{1}{12}V & -\frac{1}{4}V & -\frac{3}{4}V & -\frac{1}{4}V \\
 \hline
 & \frac{13}{12}V & \frac{1}{12}V & -\frac{1}{4}V & -\frac{3}{4}V & -\frac{1}{4}V \\
 & \frac{5}{4}A & & & &
 \end{array}$$

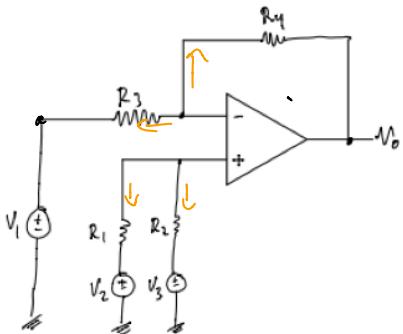
$$p_0 \Leftrightarrow N_a = \frac{13}{12}V \quad \text{svo} \quad R_{Th} = \frac{13}{12}\Omega$$

Þíneigin gatapildiðarsíða á milli pólra a & jardar er þó



Dæmi 3 – Reiknað með táknum

Finnið v_o sem fall af $v_1, v_2, v_3, R_1, R_2, R_3$ og R_4 . Lýstu í orðum hvað rásin gerir.



Vitum að $i^- = i^+ = 0$

& $V^- = V^+$

Skötum KCL við + & - pol aðgerðum magnan?

$$a: G_3(V_- - V_1) + G_4(V_- - V_o) = 0$$

$$\text{eða } V_- (G_3 + G_4) = G_3 V_1 + G_4 V_o$$

$$\text{eða } V_- = \frac{1}{G_3 + G_4} (G_3 V_1 + G_4 V_o)$$

$$b: G_1(V_+ - V_2) + G_2(V_+ - V_3) = 0$$

$$\text{eða } V_+ = \frac{1}{G_1 + G_2} (G_1 V_2 + G_2 V_3)$$

$$\text{Nu er } V_- = V_+ \text{ svo } \frac{1}{G_3 + G_4} (G_3 V_1 + G_4 V_o) = \frac{1}{G_1 + G_2} (G_1 V_2 + G_2 V_3)$$

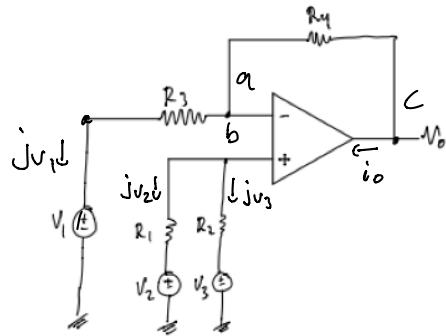
$$\text{eða } V_o = \frac{1}{G_4} \left[\frac{G_3 + G_4}{G_1 + G_2} (G_1 V_2 + G_2 V_3) - G_3 V_1 \right]$$

Rásin summer meði V_2 & V_3 , með miðun $\frac{G_1/2}{G_4} \frac{G_3 + G_4}{G_1 + G_2}$,

& dregr frí V_1 , með miðun $\frac{G_3}{G_4}$

Dæmi 3 – Reiknað með táknum

Finnið v_o sem fall af $v_1, v_2, v_3, R_1, R_2, R_3$ og R_4 . Lýstu í orðum hvað rásin gerir.

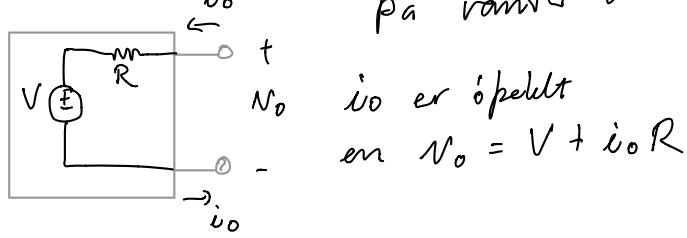


Sama dæmi leyst með MNK.

Litum á spennulind sem er rættayað með ritnum sem einn rásarhlýpur.

$$N_{\text{spennulind}} = N_{\text{hlýpur}} + N_{\text{spennlindir}} - 1$$

$$\text{pá venstre óhl} \quad N_{\text{hlýfur}} = N_{\text{hlýpur}} + N_{\text{spennlindir}} - 1 \\ = 4 + 4 - 1 = \underline{\underline{7 \text{ jölfur}}}$$



$$\begin{array}{c|ccc|ccccc}
 & a & b & c & v_1 & v_2 & v_3 & \text{noratn} \\
 \hline
 a & G_y & 0 & -G_y & 1 & 0 & 0 & 0 \\
 b & 0 & 0 & 0 & 0 & 1 & 1 & 0 \\
 c & -G_y & 0 & G_y & 0 & 0 & 0 & 1 \\
 \hline
 v_1 & 1 & 0 & 0 & -R_3 & 0 & 0 & 0 \\
 v_2 & 0 & 1 & 0 & 0 & -R_1 & 0 & 0 \\
 v_3 & 0 & 0 & 1 & 0 & 0 & -R_2 & 0 \\
 \hline
 \text{noratn} & -1 & 1 & 0 & 0 & 0 & 0 & 0
 \end{array}
 \left[\begin{array}{c} v_a \\ v_b \\ v_c \\ jv_1 \\ jv_2 \\ jv_3 \\ i_o \end{array} \right] = \left[\begin{array}{c} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{array} \right]$$

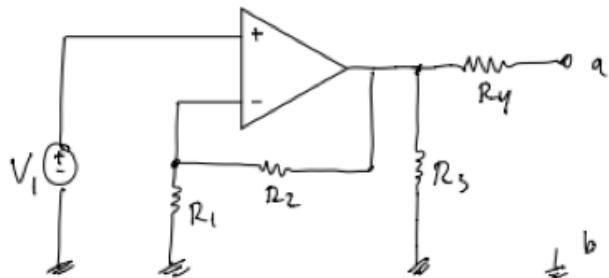
$$\begin{aligned}
 G_y(v_a - v_c) + jv_1 &= 0 \\
 jv_2 + jv_3 &= 0 \\
 G_y(v_c - v_a) + i_o &= 0 \\
 v_a - R_3 jv_1 &= v_1 \\
 v_b - R_1 jv_2 &= v_2 \\
 v_c - R_2 jv_3 &= v_3
 \end{aligned}$$

$$\begin{aligned}
 N_{\text{hl}} \text{ er } N_o &= N_c = v_2(g_1g_3 + g_1g_4) + v_3(g_2g_3 + g_2g_4) - v_1(g_1g_3 + g_2g_3) \\
 &\hline
 & g_4(g_1 + g_2)
 \end{aligned}$$

$$\begin{aligned}
 &= \frac{v_2 g_1(g_3 + g_4) + v_3 g_2(g_3 + g_4) - v_1 g_3(g_1 + g_2)}{g_4(g_1 + g_2)}
 \end{aligned}$$

Dæmi 4 – Jafngildisrásir

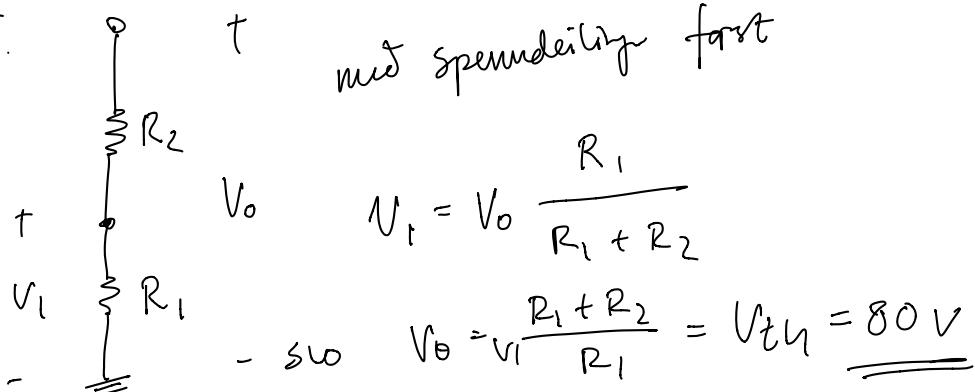
Finnið Thévenin og Norton jafngildisrásir milli póla a og b (jörð).



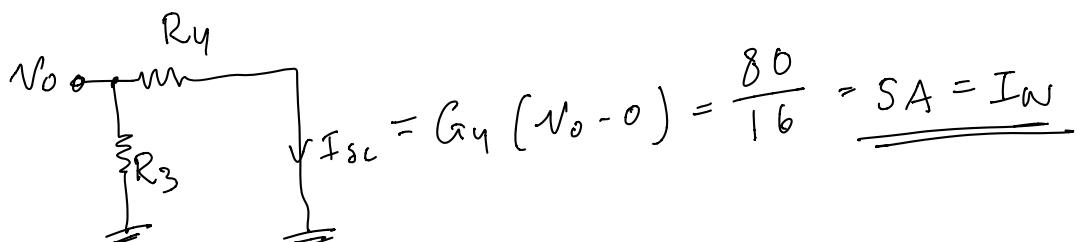
Breyta	Gildi
V_1	10 V
R_1	6Ω
R_2	42Ω
R_3	32Ω
R_4	16Ω

- ① Skoðum fyrst tómagangsspennum V_o . Hér hafa R_3 & R_4 engin áhrif vegna fæss at útgangs opamps setr út V_o , sama hrað, svo að $V^+ = V^-$

Höfum einnig að $V^+ = V^-$.



- ② Næst skamnhleyrum er í milli póla a & b



$$③ R_{eq} = \frac{V_{th}}{I_{sc}} = \frac{80}{5} = \underline{\underline{16 \Omega}}$$

