RAF201G – Miðmisserispróf 1

11. febrúar, 8:20-9:50

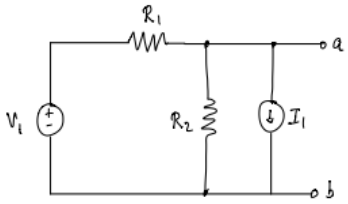
Prófið inniheldur fjögur dæmi sem hver um sig gilda 25 prósent. Setjið inn lausnir og útreikninga á Gradescope. Gangi ykkur vel!

Lausnir 9. febrúar 2021

Leiðrétt 11. febrúar 2021

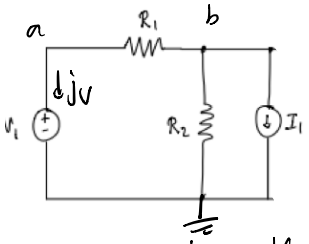
Dæmi 1 – Jafngildisrás. Óháðar lindir

Finnið tómgangsspennu v_{oc}, skammhlaupsstraum i_{sc} og jafngildisviðnám R_{eq} á milli póla a og b. Teiknið Thévenin jafngildisrásina.



Breyta	Gildi
V_1	5 V
I_1	2 A
R_1, R_2	5 Ω

(1) Voc



$N_{jöfn} = N_{hnútpunktar} + N_{spennulindir} - 1$

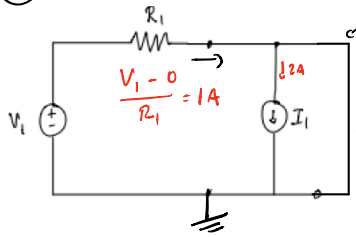
$= 3 + 1 - 1$

$= 3$ (Va, Vb, jv óþekktir)

$$\begin{array}{c} \\ a \\ b \\ V_1 \end{array} \begin{array}{c} \begin{array}{ccc} a & b & V_1 \end{array} \\ \begin{bmatrix} G_1 & -G_1 & 1 \\ -G_1 & G_1+G_2 & 0 \\ 1 & 0 & 0 \end{bmatrix} \end{array} \begin{bmatrix} V_a \\ V_b \\ jv \end{bmatrix} = \begin{bmatrix} 0 \\ -I_1 \\ V_1 \end{bmatrix} \quad \text{svo} \quad \begin{bmatrix} V_a \\ V_b \\ jv \end{bmatrix} = \begin{bmatrix} 5V \\ -\frac{5}{2}V \\ -\frac{3}{2}A \end{bmatrix}$$

þá er $V_{oc} = V_b = -\frac{5}{2}V$

(2) Isc Rásin lítur svona út



$\frac{V_1 - 0}{R_1} = 1A$

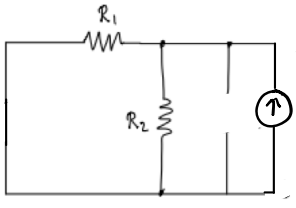
$i_{inn} = i_{út}$

$\frac{V_1 - 0}{R_1} = I_1 + I_{sc}$

svo $I_{sc} = -1A$

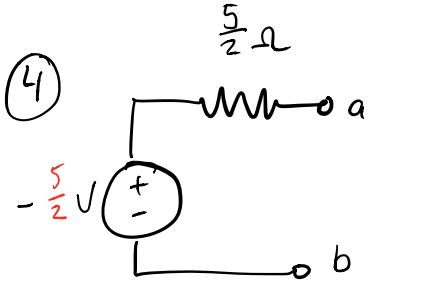
(3) $R_{th} = \frac{V_{oc}}{I_{sc}} = \frac{-5/2}{-1} = \frac{5}{2}\Omega$

Má líka núllstilla lindir & setja 1A prufustraum



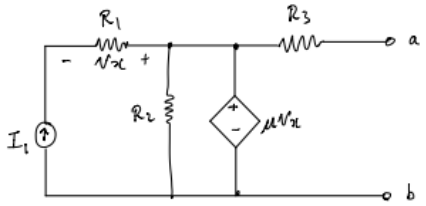
$V = 1 \cdot R_{eq} = R_1 \| R_2 = \frac{5 \cdot 5}{5+5} = \frac{5}{2}\Omega$

(4)



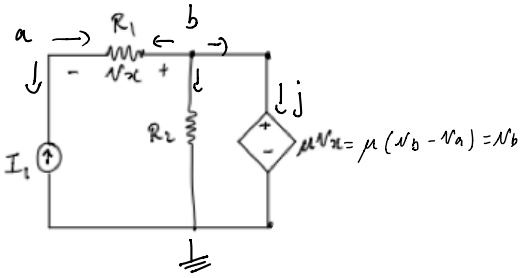
Dæmi 2 – Jafngildisrás. Spennustýrð spennulind

Finnið tómgangsspennu v_{oc}, skammhlaupsstraum i_{sc} og jafngildisviðnám R_{eq} á milli póla a og b. Teiknið Thévenin jafngildisrásina.



Breyta	Gildi
I_1	1 A
μ	4
R_1	4 Ω
R_2	6 Ω
R_3	10 Ω

① Tómgangsspennan V_{oc}

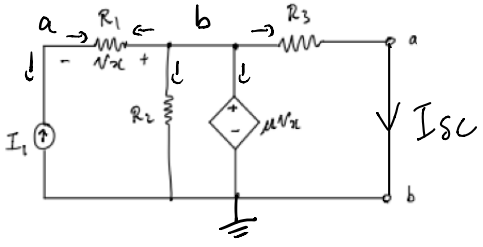


$$\begin{array}{c} \\ a \\ b \\ j \end{array} \begin{array}{c} \begin{array}{ccc} a & b & j \end{array} \\ \begin{bmatrix} G_1 & -G_1 & 0 \\ -G_1 & G_1+G_2 & 1 \\ -\mu & (\mu-1) & 0 \end{bmatrix} \end{array} \begin{bmatrix} V_a \\ V_b \\ j \end{bmatrix} = \begin{bmatrix} I_1 \\ 0 \\ 0 \end{bmatrix} \text{ svo } \begin{bmatrix} V_a \\ V_b \\ j \end{bmatrix} = \begin{bmatrix} -12\text{V} \\ -16\text{V} \\ \frac{11}{3}\text{A} \end{bmatrix}$$

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

svo $V_{oc} = V_b = -16\text{V}$

② I_{sc}

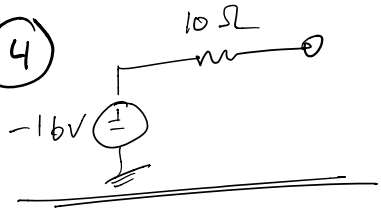


$$\begin{array}{c} \\ a \\ b \\ j \end{array} \begin{array}{c} \begin{array}{ccc} a & b & j \end{array} \\ \begin{bmatrix} G_1 & -G_1 & 0 \\ -G_1 & G_1+G_2+G_3 & 1 \\ -\mu & (\mu-1) & 0 \end{bmatrix} \end{array} \begin{bmatrix} V_a \\ V_b \\ j \end{bmatrix} = \begin{bmatrix} I_1 \\ 0 \\ 0 \end{bmatrix} \text{ svo } \begin{bmatrix} V_a \\ V_b \\ j \end{bmatrix} = \begin{bmatrix} -12\text{V} \\ -16\text{V} \\ \frac{94}{15}\text{A} \end{bmatrix}$$

þá er $I_{sc} = \dfrac{V_b - 0}{R_3} = -\dfrac{8}{5}\text{A}$

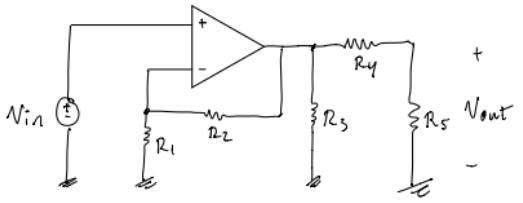
③ $R_{eq} = \dfrac{V_{oc}}{I_{sc}} = \dfrac{-16\text{V}}{-8/5\text{A}} = 10\,\Omega$

④



Dæmi 3 – Fullkominn aðgerðarmagnari

Hvaða nálgunum gerum við ráð fyrir varðandi straum og spennu ($v_{+/-}$, $i_{+/-}$) við plús/mínus póla *fullkomins* aðgerðarmagnara? Notið nálganirnar til að finna hlutfallið $v_{\text{out}}/v_{\text{in}}$.



Breyta	Gildi
R_1	$6\,\Omega$
R_2	$42\,\Omega$
R_3	$32\,\Omega$
R_4, R_5	$16\,\Omega$

Við gerum ráð fyrir $v^+ = v^-$ og $i^+ = i^- = 0\,A$

Hér $v_+ = v_- = v_{in}$

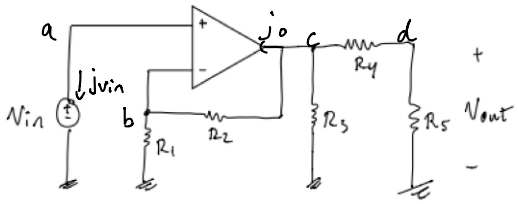
KCL í a gefur $\frac{v_{in} - 0}{R_1} = \frac{v_o - v_{in}}{R_2}$ eða $R_2 v_{in} = R_1 v_o - R_1 v_{in}$

eða $v_o = v_{in}\frac{R_1 + R_2}{R_1}$

þá er $i_{out} = \frac{v_o - 0}{R_4 + R_5}$ og $v_{out} = i_{out} R_5 = \left(\frac{v_o}{R_4 + R_5}\right) R_5$

eða $v_{out} = \left(\frac{R_5}{R_4 + R_5}\right)\left(\frac{R_1 + R_2}{R_1}\right) v_{in}$

svo $\frac{v_{out}}{v_{in}} = \frac{R_5}{R_4}\,\frac{R_1 + R_2}{R_4 + R_5} = 4$



Getum sömuleiðis leyst með MNA

$N_{jöfn} = N_{hnútp.} + N_{spennugjafar} - 1 = 4 + 2 - 1 = 5$

V_{in} er óþekkt breyta

$$\begin{array}{c} \\ a \\ b \\ c \\ d \\ V_{in} \\ \text{nullor} \end{array}\begin{array}{c} \begin{array}{cccccc} a & b & c & d & V_{in} & \text{norator} \end{array} \\ \left[\begin{array}{cccc|cc} 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & G_1+G_2 & -G_2 & 0 & 0 & 0 \\ 0 & -G_2 & G_2+G_3+G_4 & -G_4 & 0 & 1 \\ 0 & 0 & -G_4 & G_4+G_5 & 0 & 0 \\ \hline 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & -1 & 0 & 0 & 0 & 0 \end{array}\right] \end{array}\begin{bmatrix} v_a \\ v_b \\ v_c \\ v_d \\ \hline jv_{in} \\ jo \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ \hline V_{in} \\ 0 \end{bmatrix}$$

eða

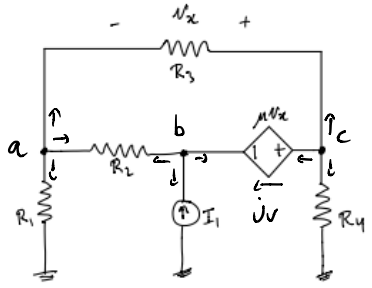
$$\begin{bmatrix} v_a \\ v_b \\ v_c \\ v_d \\ \hline jv_{in} \\ jo \end{bmatrix} = \begin{bmatrix} V_{in}\ V \\ V_{in}\ V \\ 8V_{in}\ V \\ 4\ V \\ 0\ A \\ -\frac{2}{3}V_{in}\ A \end{bmatrix}$$

Svo $\dfrac{V_{out}}{V_{in}} = \dfrac{V_d}{V_{in}} = \dfrac{4V_{in}}{V_{in}} = 4$

Dæmi 4 – Hnútpunktagreining (MNA)

Ritið KCL og KVL jöfnur sem duga til að leysa rásina hér að neðan. Setjið jöfnurnar upp í fylki. Athugið að ekki þarf að leysa fylkið.

Ábending: Hvað eru margir hnútpunktar og spennulindir? Hvað eru þá margar óþekktar breytur/jöfnur sem þarf að leysa?



Breyta	Gildi
μ	3
I_1	6 A
R_1	$\frac{1}{6}\,\Omega$
R_2	$\frac{1}{3}\,\Omega$
R_3	$\frac{1}{2}\,\Omega$
R_4	$\frac{1}{30}\,\Omega$

$N_{jöfn} = N_{hnútpunktar} + N_{spennulindir} - 1$

$= 4 + 1 - 1 = 4$

Veit einnig að $V_c - V_b = \mu (V_c - V_a)$

eða $V_c(\mu - 1) - \mu V_a + V_b = 0$

$$\begin{array}{c} \\ a \\ b \\ c \\ VCVS \end{array} \begin{array}{c} \begin{array}{cccc} a & b & c & VCVS \end{array} \\ \left[\begin{array}{cccc|c} G_1+G_2+G_3 & -G_2 & -G_3 & 0 \\ -G_2 & G_2 & 0 & -1 \\ -G_3 & 0 & G_3+G_4 & 1 \\ \hline \mu & 1 & \mu+1 & 0 \end{array}\right] \end{array} \begin{bmatrix} V_a \\ V_b \\ V_c \\ \hline jv \end{bmatrix} = \begin{bmatrix} 0 \\ I_1 \\ 0 \\ \hline 0 \end{bmatrix}$$

eða

$$\begin{bmatrix} V_a \\ V_b \\ V_c \\ \hline jv \end{bmatrix} = \begin{bmatrix} -\frac{2}{3}\,V \\ -\frac{8}{3}\,V \\ \frac{1}{3}\,V \\ \hline -12\,A \end{bmatrix}$$