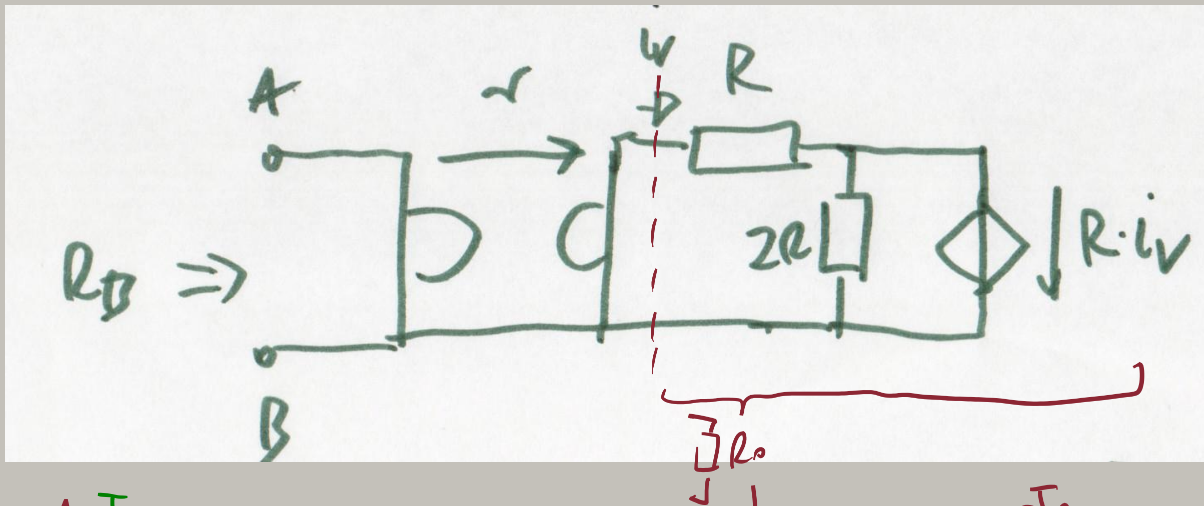
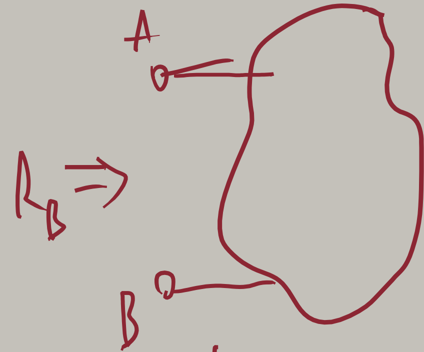
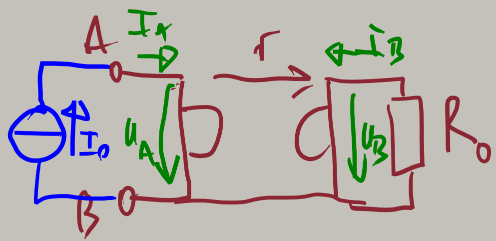
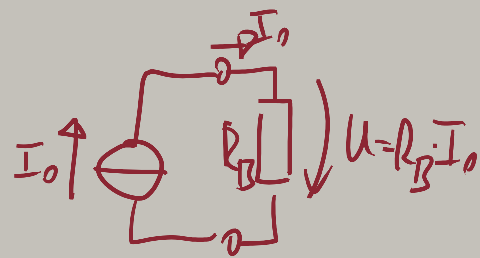
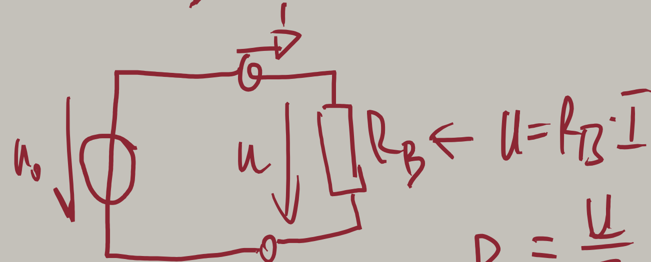










$$R_B = \frac{U}{I}$$

U_A-t keressük!

1) $I_A = I_0$

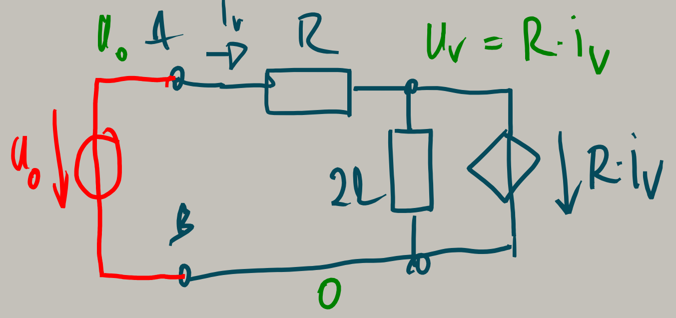
2) $U_A = -r \cdot I_B$

3) $U_B = r \cdot I_A$

4) $U_B = -I_B \cdot R_0$

$$U_A = -r \cdot \left(-\frac{U_B}{R_0}\right) = r \cdot \frac{1}{R_0} \cdot (r \cdot I_0) = \frac{r^2}{R_0} \cdot I_0$$

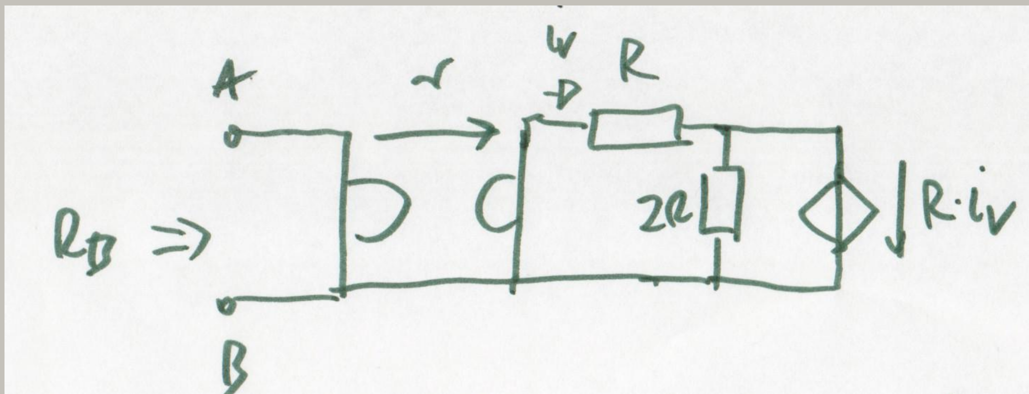
$$R_{AB} = \frac{U_A}{I_A} = \frac{r^2/R_0 \cdot I_0}{I_0} = \frac{r^2}{R_0}$$



$R_{AB} = \frac{U_0}{I_v}$

$\rightarrow \quad I_v = \frac{U_0 - U_v}{R} = \frac{U_0 - R\cdot I_v}{R} \Rightarrow 2R\, I_v = U_0 \qquad I_v = \frac{U_0}{2R}$

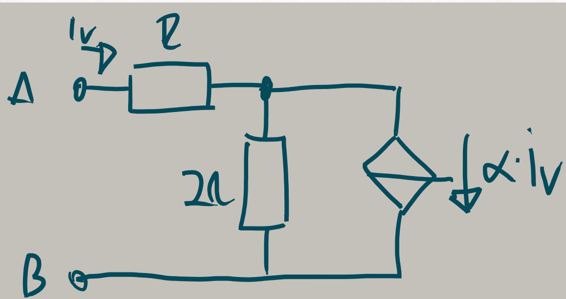
$R_{AB} = \frac{U_0}{U_0/2R} = 2R$



Teljes feladat:

$R_{AB} = \frac{r^2}{R_0} = \frac{r^2}{2R}$

Otthoni feldolgozásra

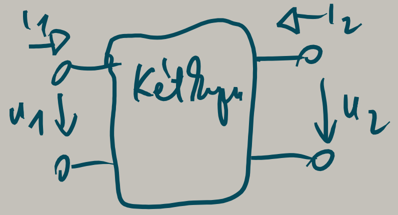


$R_{AB} = ?$

$\left(R_{AB} = R\cdot\frac{3-2\alpha}{1+4\alpha} \right)$

Kétkapu:

(Two-port)



u_1, i_1, u_2, i_2

lineáris kétkapu

$$\begin{pmatrix} \cdot \\ \cdot \end{pmatrix} = \begin{pmatrix} \cdot & \cdot \\ \cdot & \cdot \end{pmatrix} \cdot \begin{pmatrix} \cdot \\ \cdot \end{pmatrix}$$

függő változók

karakterisztikus mátrix

független v. (ok változtatható)

hibrid típusú kar.

u_1 v. i_1

$$\begin{pmatrix} \cdot_1 \\ \cdot_2 \end{pmatrix} = \begin{pmatrix} & \\ & \end{pmatrix} \cdot \begin{pmatrix} \cdot_1 \\ \cdot_2 \end{pmatrix}$$

u_2 v. i_2

lánc típusú kar.

$$\begin{pmatrix} u_1 \\ i_1 \end{pmatrix} = \begin{pmatrix} & \\ & \end{pmatrix} \begin{pmatrix} u_2 \\ i_2 \end{pmatrix}$$

vagy fordítva

4 féle, hibrid

R, G, H, K ← inverz hibrid

(Z), (Y)

[Ω] [S]

$$\begin{pmatrix} u_1 \\ u_2 \end{pmatrix} = \begin{pmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{pmatrix} \cdot \begin{pmatrix} i_1 \\ i_2 \end{pmatrix}$$

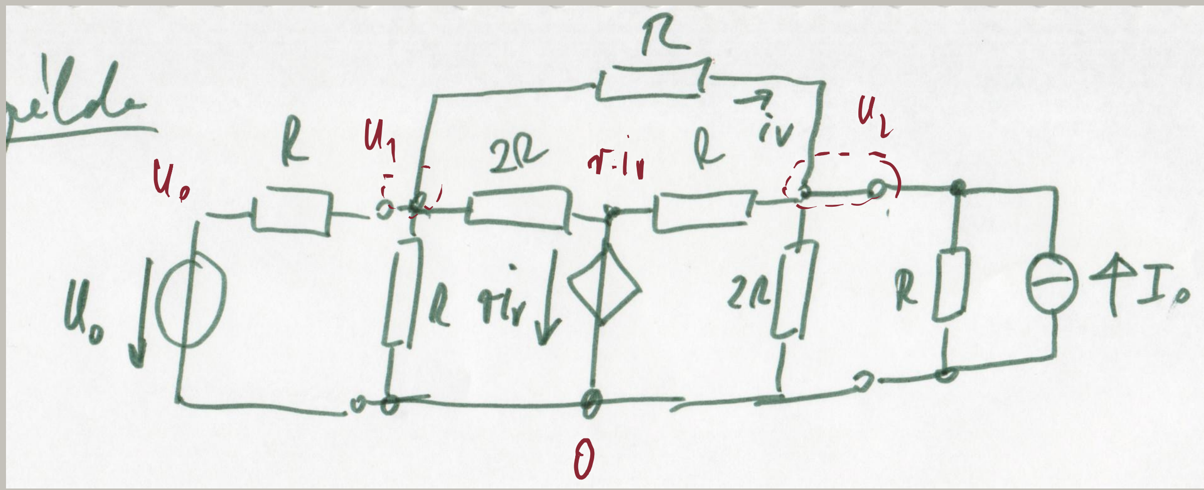
$$\begin{pmatrix} i_1 \\ i_2 \end{pmatrix} = \begin{pmatrix} G_{11} & G_{12} \\ G_{21} & G_{22} \end{pmatrix} \begin{pmatrix} u_1 \\ u_2 \end{pmatrix}$$

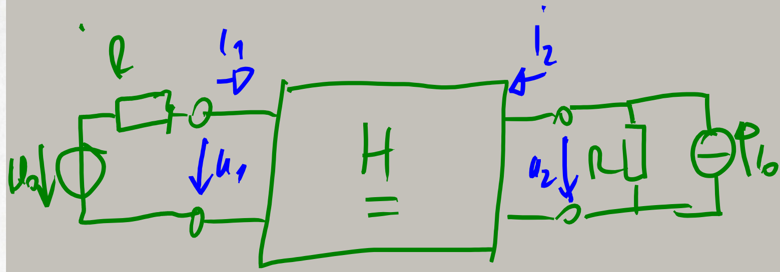
$$\begin{pmatrix} u_1 \\ i_2 \end{pmatrix} = \begin{pmatrix} H_{11} & H_{12} \\ H_{21} & H_{22} \end{pmatrix} \cdot \begin{pmatrix} i_1 \\ u_2 \end{pmatrix}$$

$[1]$ $[1/\Omega]$

$$u_1 = \overbrace{H_{11}}^{[\Omega]} \cdot i_1 + \overset{[1]}{H_{12}} \cdot u_2$$

$$\begin{pmatrix} i_1 \\ u_2 \end{pmatrix} = \begin{pmatrix} & \\ & \end{pmatrix} \begin{pmatrix} u_1 \\ i_2 \end{pmatrix}$$





- $r = 4\,\Omega$; $R = 10\,\Omega$; $U_0 = 10\,V$; $I_0 = 0{,}1\,A$
- Ω, V, A koherens egységrendszer
- ismeretlenek: U_1, U_2, i_v

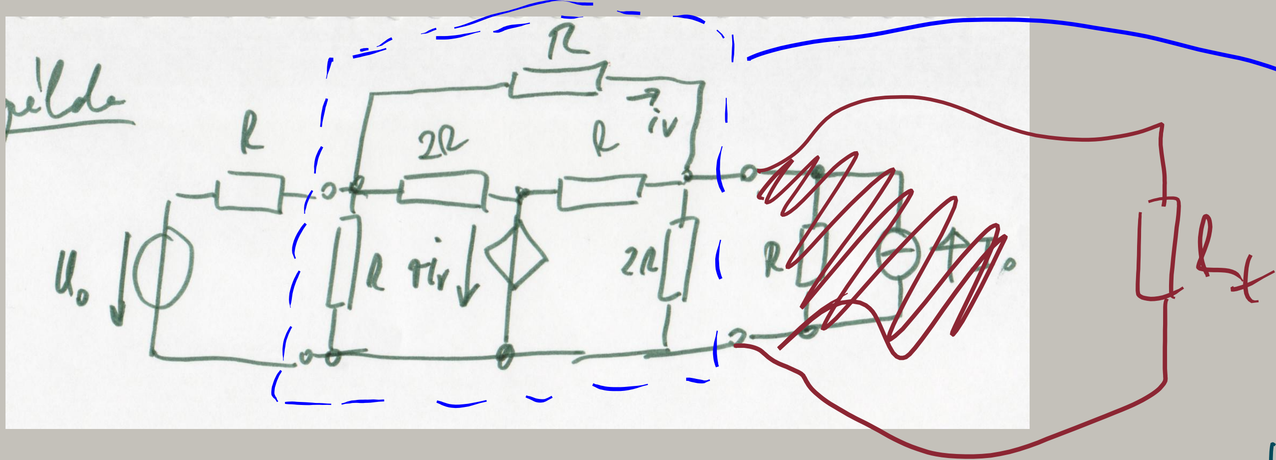
1) $$\frac{U_1 - U_0}{R} + \frac{U_1}{R} + \frac{U_1 - r i_v}{2R} + \frac{U_1 - U_2}{R} = 0$$

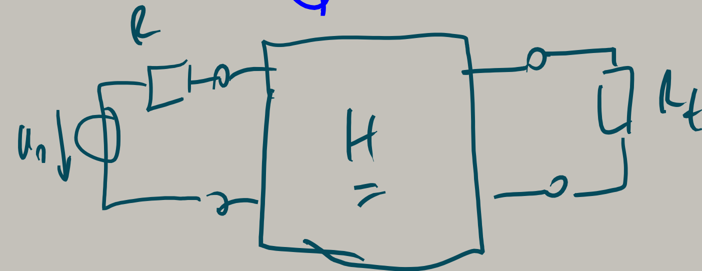
2) $$-I_0 + \frac{U_2}{R} + \frac{U_2}{2R} + \frac{U_2 - r i_v}{R} + \frac{U_2 - U_1}{R} = 0$$

3) $$i_v = \frac{U_1 - U_2}{R}$$

$$\hookrightarrow \; i_v - \frac{U_1}{R} + \frac{U_2}{R} = 0$$

$$\underbrace{\begin{array}{ccc} U_1 & U_2 & i_v \\ \left(\begin{matrix} \frac{3}{R} + \frac{1}{2R} & -\frac{1}{R} & -\frac{r}{2R} \\ -\frac{1}{R} & \frac{3}{R} + \frac{1}{2R} & -\frac{r}{R} \\ -\frac{1}{R} & \frac{1}{R} & 1 \end{matrix}\right) \end{array}}_{\underline{\underline{A}}} \cdot \underbrace{\begin{pmatrix} U_1 \\ U_2 \\ i_v \end{pmatrix}}_{\underline{x}} = \underbrace{\begin{pmatrix} U_0/R \\ I_0 \\ 0 \end{pmatrix}}_{\underline{B}}$$





$$
\begin{array}{cccc}
 & u_1 & u_2 & i_v \\
\end{array}
$$

$$
\underbrace{\begin{pmatrix} \frac{3}{R}+\frac{1}{2R} & -\frac{1}{R} & -\frac{r}{2R} \\ -\frac{1}{R} & \frac{3}{R}+\frac{1}{2R} & -\frac{r}{R} \\ -\frac{1}{R} & \frac{1}{R} & 1 \end{pmatrix}}_{\underline{\underline{A}}} \cdot \underbrace{\begin{pmatrix} u_1 \\ u_2 \\ i_v \end{pmatrix}}_{\underline{x}} = \underbrace{\begin{pmatrix} U_0/R \\ I_0 \\ 0 \end{pmatrix}}_{\underline{B}}
$$

$$\frac{3}{R} \to \frac{2}{R} + \frac{1}{R_t}$$

$$I_0 \to 0$$

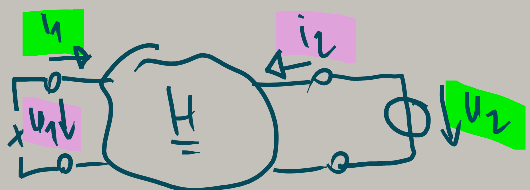
paraméterek számítása

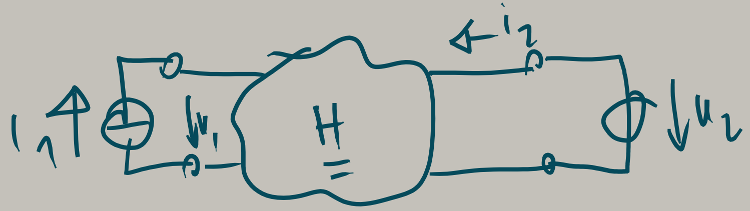
$\underline{\underline{H}}$:

$$u_1 = H_{11} \cdot i_1 + \cancel{H_{12}\, u_2}$$

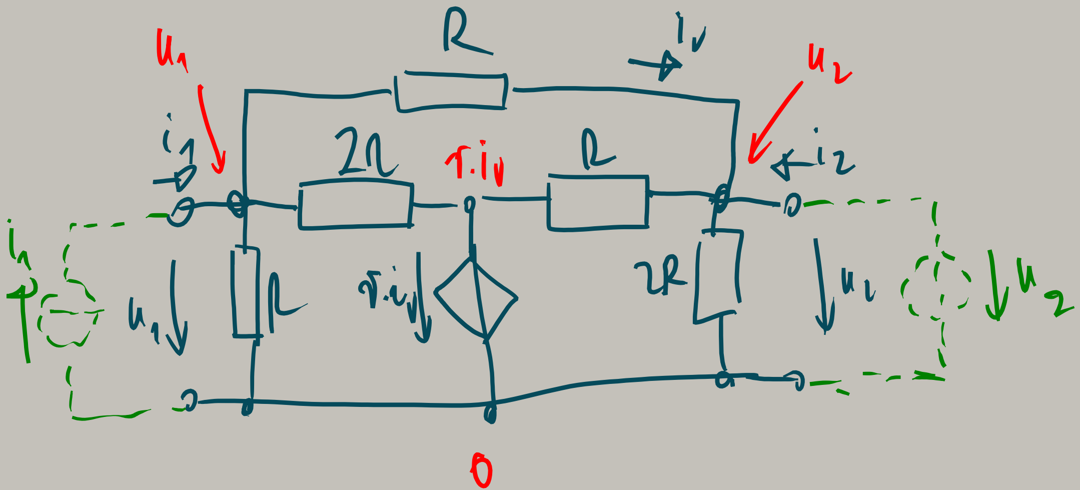
$$\hookrightarrow \left.\frac{u_1}{i_1}\right|_{u_2=0} \to\ ?$$

$$i_2 = H_{21} \cdot i_1 + \cancel{H_{22}\, u_2}$$





H_{11} ... $\Rightarrow u_1, i_2$



fontos

ismeretlen: $u_1, \cancel{i_1}, \cancel{u_2}, i_2, i_v$

1) $-i_1 + \frac{u_1}{R} + \frac{u_1 - r i_v}{2R} + \frac{u_1 - u_2}{R} = 0$

2) $-i_2 + \frac{u_2}{2R} + \frac{u_2 - r i_v}{R} + \frac{u_2 - u_1}{R} = 0$

3) $i_v = \frac{u_1 - u_2}{R}$

$$\begin{array}{ccc} u_1 & i_2 & i_v \end{array}$$
$$\begin{pmatrix} \frac{2}{R} + \frac{1}{2R} & 0 & -\frac{r}{2R} \\ -\frac{1}{R} & -1 & -\frac{r}{R} \\ -\frac{1}{R} & 0 & 1 \end{pmatrix} \begin{pmatrix} u_1 \\ i_2 \\ i_v \end{pmatrix} = \begin{pmatrix} i_1 + \frac{u_2}{R} \\ -u_2 \cdot \left(\frac{2}{R} + \frac{1}{2R}\right) \\ -\frac{u_2}{R} \end{pmatrix} = \begin{array}{c} \begin{array}{cc} i_1 & u_2 \end{array} \\ \begin{pmatrix} 1 & \frac{1}{R} \\ 0 & -\frac{5}{2R} \\ 0 & -\frac{1}{R} \end{pmatrix} \end{array} \cdot \begin{pmatrix} i_1 \\ u_2 \end{pmatrix}$$

$$\underline{\underline{P}} \cdot \underline{x} = \underline{\underline{Q}} \cdot \underline{s}$$

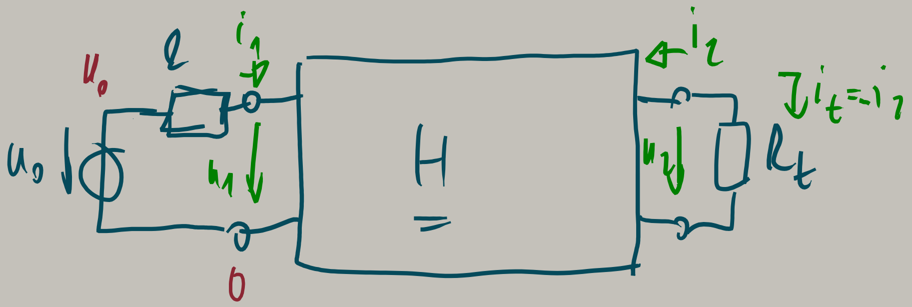
$$\underline{\underline{P}} \cdot \underline{x} = \underline{\underline{Q}} \cdot \underline{s} \longrightarrow \underline{x} = \underline{\underline{P}}^{-1} \cdot \underline{\underline{Q}} \cdot \underline{s}$$

$$\underbrace{\begin{pmatrix}\cdot&\cdot&\cdot\\ \cdot&\cdot&\cdot\\ \cdot&\cdot&\cdot\end{pmatrix}}_{3\times 3}\cdot\begin{pmatrix}\cdot\\ \cdot\\ \cdot\end{pmatrix} = \underbrace{\begin{pmatrix}\cdot&\cdot\\ \cdot&\cdot\\ \cdot&\cdot\end{pmatrix}}_{3\times 2}\cdot\begin{pmatrix}\cdot\\ \cdot\end{pmatrix}$$

$$\begin{pmatrix}\cdot\\ \cdot\\ \cdot\end{pmatrix} = \underbrace{\begin{pmatrix}\cdot&\cdot&\cdot\\ \cdot&\cdot&\cdot\\ \cdot&\cdot&\cdot\end{pmatrix}\begin{pmatrix}\cdot&\cdot\\ \cdot&\cdot\\ \cdot&\cdot\end{pmatrix}}_{\begin{pmatrix}\cdot&\cdot\\ \cdot&\cdot\\ \cdot&\cdot\end{pmatrix}}\cdot\begin{pmatrix}\cdot\\ \cdot\end{pmatrix} = \begin{pmatrix}\cdot\\ \cdot\\ \cdot\end{pmatrix}$$

$$\begin{pmatrix}u_1\\ i_2\\ i_v\end{pmatrix} = \begin{pmatrix}\cdot&\cdot\\ \cdot&\cdot\\ \cdot&\cdot\end{pmatrix}\cdot\begin{pmatrix}i_1\\ u_2\end{pmatrix}$$

$\underline{\underline{H}}$



kétkapu felől nézve

1) $u_1 = H_{11}\cdot i_1 + H_{12}\cdot u_2$

2) $i_2 = H_{21}\cdot i_1 + H_{22}\cdot u_2$

4 ismeretlen (2 kap.)

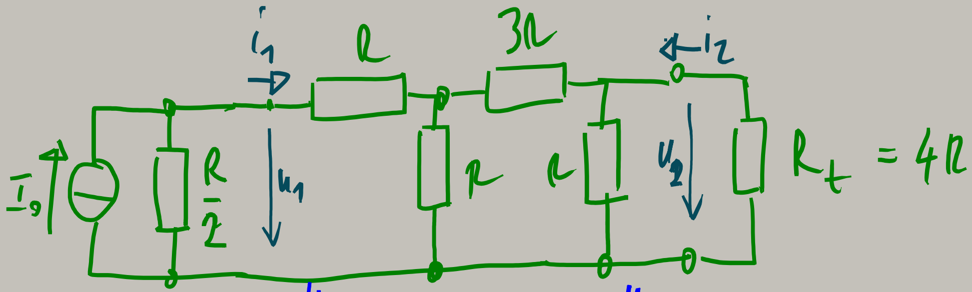
primer oldali (1): $i_1 + \dfrac{u_1 - u_0}{R} = 0$ 3)

szekunder oldal (2): $u_2 = (-i_2)\cdot R_t$ 4)

$$\begin{array}{cccc} u_1 & u_2 & i_1 & i_2 \\ \end{array}$$
$$\begin{pmatrix} 1 & -H_{12} & -H_{11} & 0 \\ 0 & -H_{22} & -H_{21} & 1 \\ 1 & 0 & R & 0 \\ 0 & 1 & 0 & R_t \end{pmatrix}\begin{pmatrix}u_1\\ u_2\\ i_1\\ i_2\end{pmatrix} = \begin{pmatrix}0\\ 0\\ u_0\\ 0\end{pmatrix}$$

tetszőleges R_t:

$R_t = 10\,\Omega$

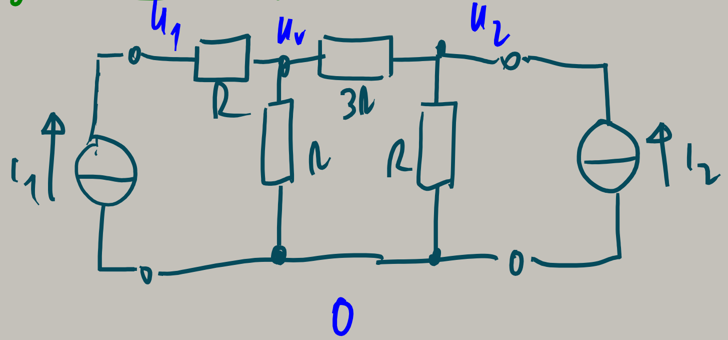


$P_t = ?$

$R = 2{,}97\ k\Omega$

$I_0 = 2\ mA$

$\underline{\underline{R}}$:



1) $-i_1 + \frac{u_1 - u_v}{R} = 0$

2) $-i_2 + \frac{u_2}{R} + \frac{u_2 - u_v}{3R} = 0$

3) $\frac{u_v - u_1}{R} + \frac{u_v}{R} + \frac{u_v - u_2}{3R} = 0$

$3R \cdot 3)$

$7u_v = 3u_1 + u_2$

$u_v = \frac{3}{7}u_1 + \frac{1}{7}u_2$

$$i_1 = \frac{1}{R}u_1 - \frac{1}{R}\left(\frac{3}{7}u_1 + \frac{1}{7}u_2\right) = \frac{4}{7R}u_1 - \frac{1}{7R}u_2$$

$$i_2 = \frac{4}{3R}u_2 - \frac{1}{3R}\left(\frac{3}{7}u_1 + \frac{1}{7}u_2\right) = -\frac{1}{7R}u_1 + \frac{27}{21R}\cdot u_2$$

$$\Rightarrow \underline{\underline{G}} = \begin{pmatrix} \frac{4}{7R} & -\frac{1}{7R} \\ -\frac{1}{7R} & \frac{27}{21R} \end{pmatrix}$$

$$\underline{\underline{R}} = \underline{\underline{G}}^{-1} = R \cdot \begin{pmatrix} 1{,}8 & 0{,}2 \\ 0{,}2 & 0{,}8 \end{pmatrix} = \begin{pmatrix} \frac{9R}{5} & \frac{R}{5} \\ R/5 & 4R/5 \end{pmatrix}$$