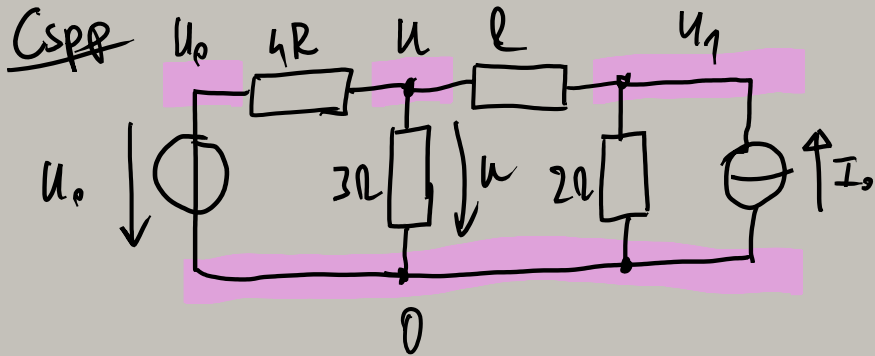
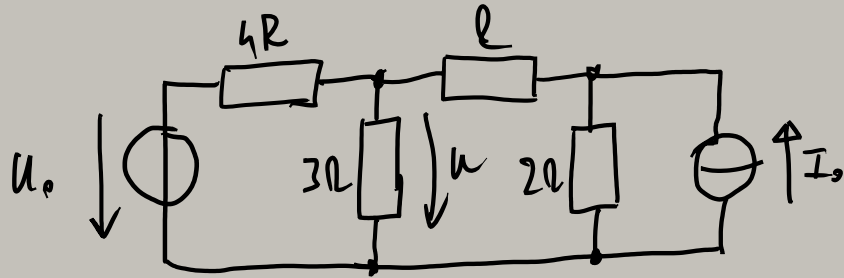


Bemerkung feldat

$$U_0 = 12V; I_0 = 2mA; R = 2k\Omega$$

$$V_1 \text{ mA, k}\Omega$$



$$\left. \begin{aligned} \left(\frac{1}{4R} + \frac{1}{3R} + \frac{1}{R}\right)u + \left(-\frac{1}{R}\right)u_1 &= \frac{1}{4R} \cdot U_0 \\ \left(-\frac{1}{R}\right) \cdot u + \left(\frac{1}{R} + \frac{1}{2R}\right)u_1 &= I_0 \end{aligned} \right\}$$

4 db csp \Rightarrow 2 db ismentler

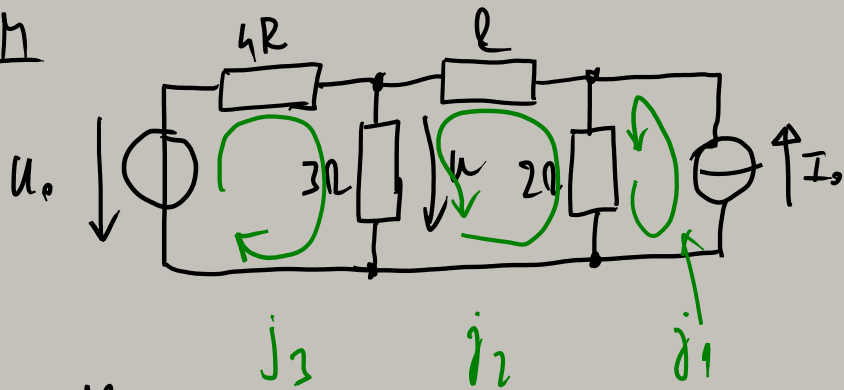
$$\frac{u - u_1}{4R} + \frac{u}{3R} + \frac{u - u_1}{R} = 0 \quad (1)$$

$$-I_0 + \frac{u_1}{2R} + \frac{u_1 - u}{R} = 0 \quad (2)$$

$$u = 6,1818V$$

$$u_1 = 6,7878V$$

HAM



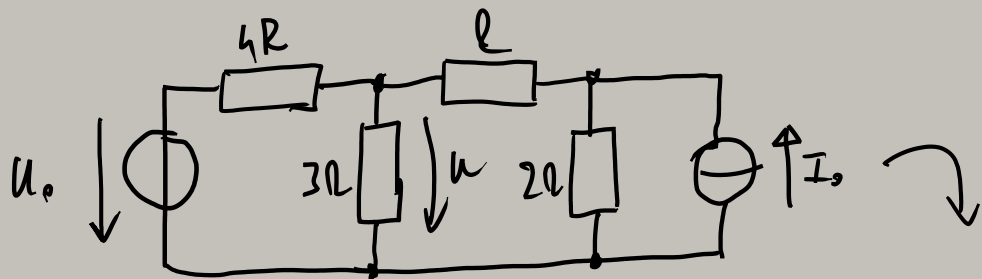
ismertlme: j_2, j_3

$$\left. \begin{aligned} (2R+R+3R) j_2 + 3R j_3 &= 2R I_0 \\ 3R j_2 + (3R+4R) j_3 &= u_0 \end{aligned} \right\}$$

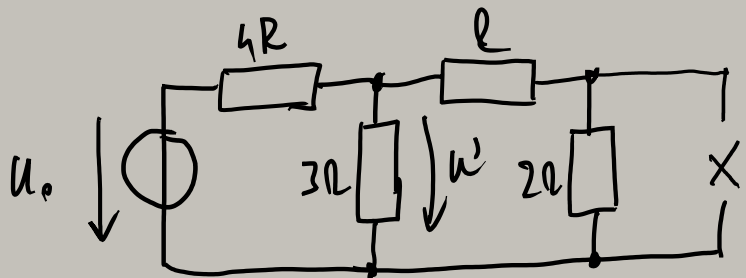
$$\left. \begin{aligned} 12 j_2 + 6 j_3 &= 8 \\ 6 j_2 + 14 j_3 &= 12 \end{aligned} \right\} \begin{aligned} j_2 &= 0,3030 \text{ mA} \\ j_3 &= 0,7272 \text{ mA} \end{aligned}$$

$$u = 3R \cdot (j_2 + j_3) = 6 \cdot \Omega \cdot (1,0302) = 6,1812 \text{ V}$$

$$\left. \begin{aligned} j_1 &= I_0 \\ 2R(j_2 - j_1) + R \cdot j_2 + 3R(j_2 + j_3) &= 0 \\ -u_0 + 4R j_3 + 3R(j_3 + j_2) &= 0 \end{aligned} \right\}$$

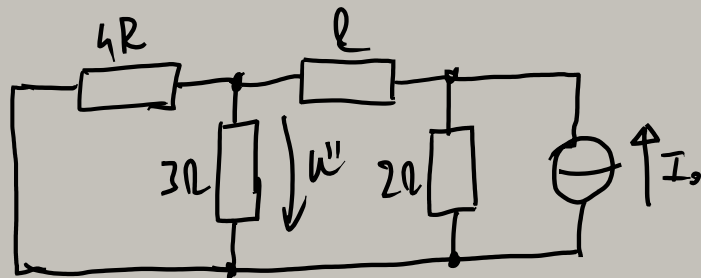


$$u = u' + u''$$



$$I_0 = 0$$

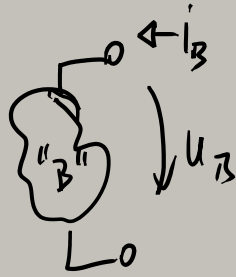
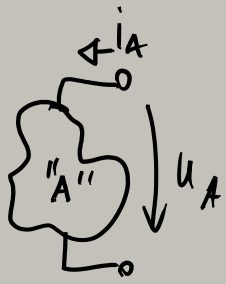
$$u' = u_0 \cdot \frac{3R \times (R + 2R)}{4R + (3R \times (R + 2R))} = u_0 \cdot \frac{3R/2}{11R/2} = \frac{3u_0}{11}$$



$$u_0 = 0$$

$$u'' = \frac{2R \times (R + 3R \times 4R)}{R + (3R \times 4R)} \cdot \frac{4R \times 3R}{3R} \cdot 3R = u''$$

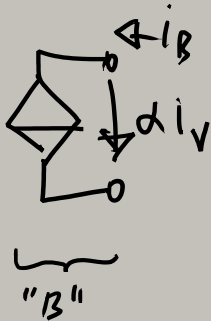
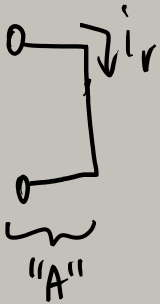
$$3R \times 4R = \frac{12R}{7}$$



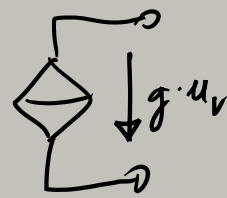
$$u_A = f(i_A, u_B)$$

$$i_B = g(i_A, u_B)$$

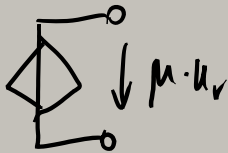
AME mit en gellezi a f is s, hory
linearis legge us e dit tip-les



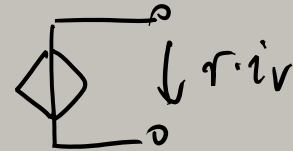
$$\frac{A'VA'F}{i_B = \alpha \cdot i_v}$$



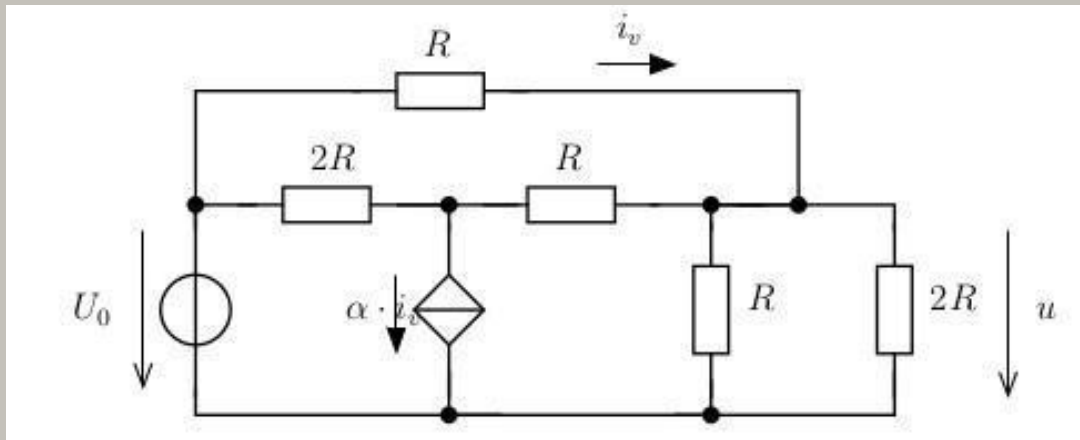
$$\frac{FVA'F}$$



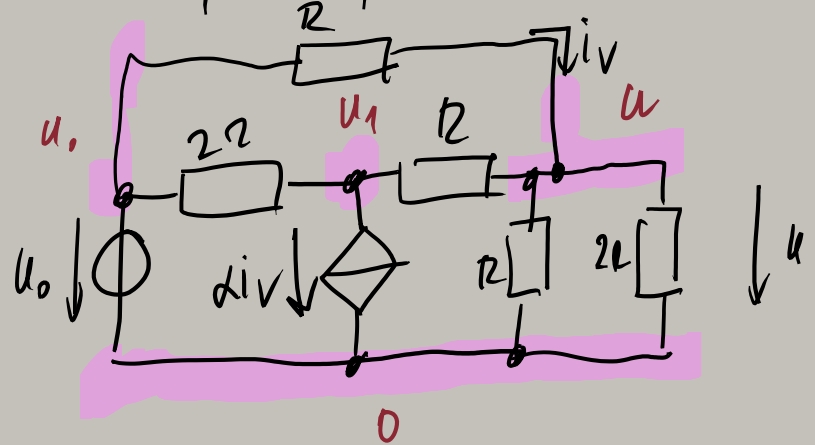
$$\frac{\neq VFF}{}$$



$$\frac{A'VFF}{}$$



$U_0 = 10V ; R = 5\Omega ; \alpha = 0,9$



$$\frac{u}{2R} + \frac{u}{R} + \frac{u-u_1}{R} + \frac{u-U_0}{R} = 0$$

$$\frac{u_1-U_0}{2R} + \frac{u_1-u}{R} + \alpha \cdot i_v = 0$$

$$i_v + \frac{u}{R} = \frac{U_0}{R}$$

$$i_v = \frac{U_0 - u}{R}$$

lin. system

$$\underline{A} \cdot \underline{x} = \underline{B}$$

$$\underline{x} = \underline{A}^{-1} \cdot \underline{B}$$

$$\underbrace{\underline{A}^{-1} \cdot \underline{A}}_{\underline{E}} \cdot \underline{x} = \underline{A}^{-1} \cdot \underline{B}$$

isometrisch: u, u_1, i_v

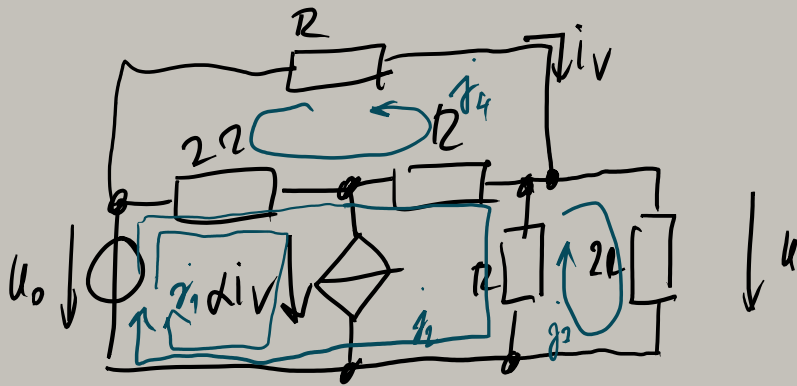
$$\begin{pmatrix} \frac{3}{R} + \frac{1}{2R} & -\frac{1}{R} & 0 \\ -\frac{1}{R} & \frac{1}{R} + \frac{1}{2R} & \alpha \\ \frac{1}{R} & 0 & 1 \end{pmatrix} \begin{pmatrix} u \\ u_1 \\ i_v \end{pmatrix} = \begin{pmatrix} U_0/R \\ U_0/2R \\ U_0/R \end{pmatrix}$$

$\underline{A} \cdot \underline{x} = \underline{B}$

$$\underline{x} = \begin{pmatrix} 3,2836 \text{ V} \\ 4,4925 \text{ V} \\ 1,3433 \text{ V} \end{pmatrix}$$

$$\Rightarrow u = 3,2836 \text{ V}$$

Egy lehetséges megoldás hurok-áramok módszerével:



$$u = +j_3 \cdot 2R = 0,3784 \cdot 2 \cdot R = 3,2836 \text{ V}$$

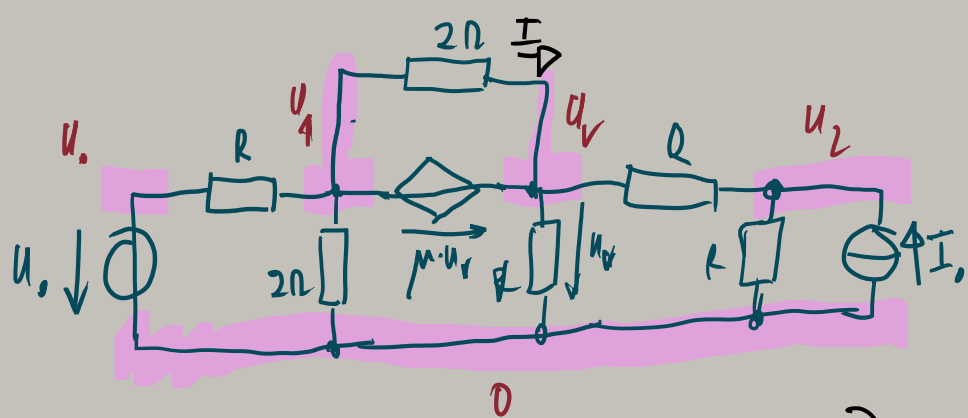
- meggyőző a fenti eredményzel
 - egyenlettel történő számítás az A-ban való feloldás miatt is jellelő
- (1) $\hookrightarrow (\dots)$ (2) $\hookrightarrow (\dots)$...

$$\begin{aligned} 5) \quad & i_v = -i_4 \\ 4) \quad & R j_4 + 2R \cdot (j_1 + j_2 + j_4) + R(j_4 + j_2) = 0 \\ 3) \quad & 2R j_3 + R(j_3 - j_2) = 0 \\ & -U_0 + 2R(j_1 + j_2 + j_4) + R(j_2 + j_4) + \\ & + R(j_2 - j_3) = 0 \\ 2) \quad & \end{aligned}$$

$$1) \quad \alpha i_v = j_1$$

$$\begin{pmatrix} j_1 & j_2 & j_3 & j_4 & i_v \\ 1 & \cdot & \cdot & \cdot & -\alpha \\ 2R & 4R & -R & 3R & \cdot \\ \cdot & -R & 3R & \cdot & \cdot \\ 2R & 3R & \cdot & 4R & \cdot \\ \cdot & \cdot & \cdot & 1 & 1 \end{pmatrix} \begin{pmatrix} j_1 \\ j_2 \\ j_3 \\ j_4 \\ i_v \end{pmatrix} = \begin{pmatrix} 0 \\ U_0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

2)



$$1) U_1 = U_V + \mu \cdot U_V$$

$$2) \frac{U_1}{2R} + \frac{U_1 - U_0}{R} + \frac{U_V}{R} + \frac{U_V - U_2}{R} = 0$$

$$3) -I_0 + \frac{U_2}{R} + \frac{U_2 - U_V}{R} = 0$$

$$I = \frac{\mu \cdot U_V}{2R} = 0,5 \text{ mA}$$

forrásról teljesítmény:

$$I_{UV} = - \left(\frac{U_1}{2R} + \frac{U_1 - U_0}{R} + \frac{\mu U_V}{2R} \right) = 0,1429 \text{ mA}$$

Ismeretlenek: (most visszafelé a cspp-t választva)

$$U_1, U_2, U_V$$

$$\begin{pmatrix} U_1 \\ U_2 \\ U_V \end{pmatrix} = \begin{pmatrix} 1 & 0 & -(1+\mu) \\ \frac{3}{2R} & -\frac{1}{R} & \frac{2}{R} \\ 0 & \frac{2}{R} & -\frac{1}{R} \end{pmatrix} \begin{pmatrix} 0 \\ U_0/R \\ I_0 \end{pmatrix}$$

$$U_1 = 13,6 \text{ V}$$

$$U_2 = 12,4 \text{ V}$$

$$U_V = 8 \text{ V}$$

$$P_{UV} = \mu \cdot U_V \cdot I_{UV} = 0,8 \text{ mW}$$

a visszatér forrás fogyasztásait működés!

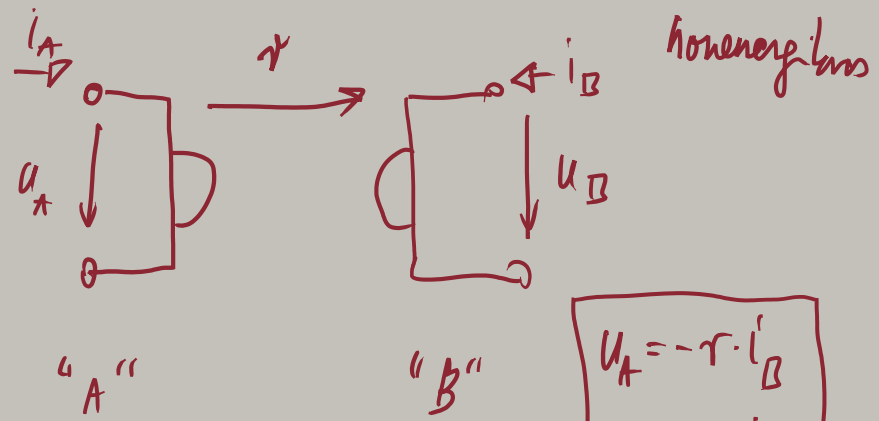
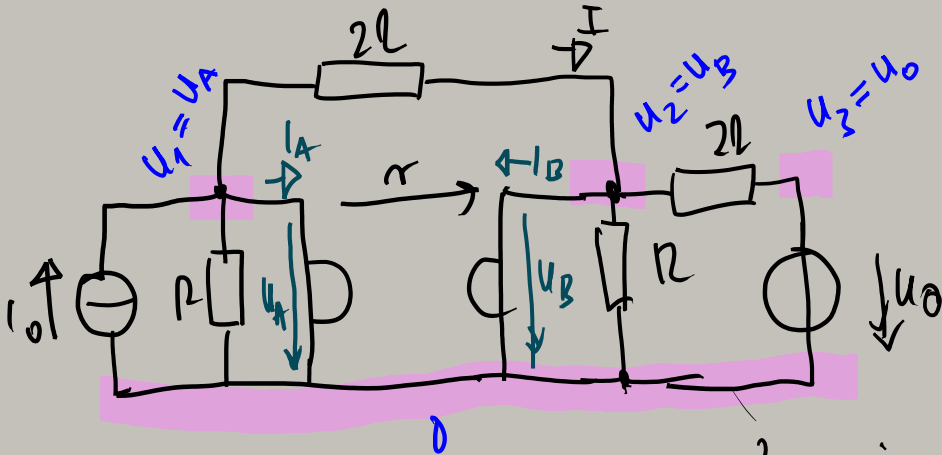
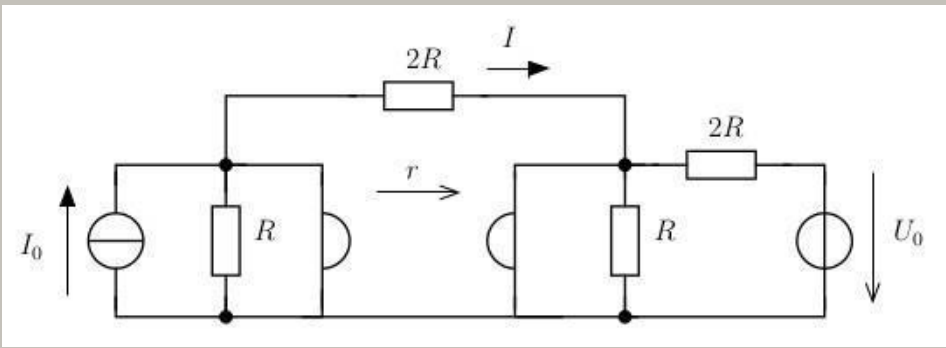
fen. formák: $I_{us} = \frac{u_1 - u_2}{R} = -1,8571 \text{ mA}$ $P_{us} = -44,571 \text{ mW}$ (termelőként viselkedik)

áram formák: $u_{is} = 0 - u_2 = -12,4 \text{ V}$ $P_{is} = -37,2 \text{ mW}$ (termelő)

Nehézebb feladatok:

1) Határozd meg μ azon értéktartományát, amikor a vezérelt forrás fogyasztóként viselkedik!

2) Rajzoljál az u_o -l. paraméterezésen (u_o és i_o által definiált szél, ahol a változók u_o és i_o) az adott μ értékek tartományán, mely tartományon lesz az egyes források termelő jellegűek! (Hátfelül van kell a különböző kombinációk vizsgálatára?)



$$\begin{aligned} U_A &= -r \cdot i_B \\ U_B &= r \cdot i_A \end{aligned}$$

$$U_A i_A + U_B i_B =$$

$$U_A \cdot \frac{U_B}{r} + U_B \cdot \left(-\frac{U_A}{r} \right) = 0$$

isshemethen: U_A, U_B, I_A, I_B, I

2 eq-i ayphelt
2 kmbht.

$$1) -I_0 + \frac{U_A}{R} + \frac{U_A - U_B}{2R} + I_A = 0$$

$$2) \frac{U_B - U_0}{2R} + \frac{U_B}{R} + \frac{U_B - U_A}{2R} + I_B = 0$$

$$3) U_A = -r \cdot I_B$$

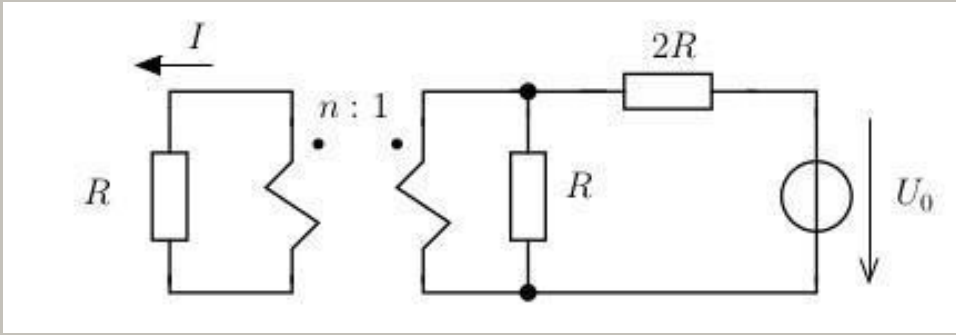
$$4) U_B = r \cdot I_A$$

$$I_B = -\frac{U_A}{r}$$

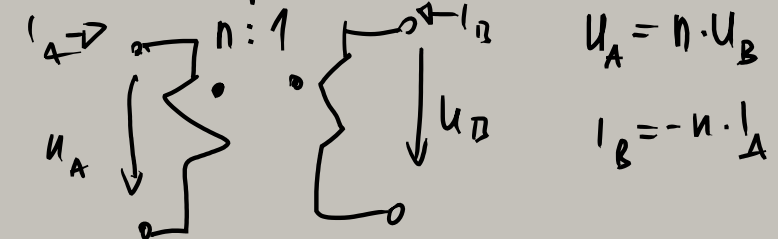
$$I_A = \frac{U_B}{r}$$

$$\left. \begin{aligned} \frac{U_B - U_0}{2R} + \frac{U_B}{R} + \frac{U_B - U_A}{2R} - \frac{U_A}{r} &= 0 \quad \textcircled{2} \\ -I_0 + \frac{U_A}{R} + \frac{U_A - U_B}{2R} + \frac{U_B}{r} &= 0 \quad \textcircled{1} \end{aligned} \right\}$$

$$\begin{pmatrix} \left(\frac{1}{R} + \frac{1}{2R} \right) & \frac{1}{r} - \frac{1}{2R} \\ -\frac{1}{r} - \frac{1}{2R} & \frac{2}{R} \end{pmatrix} \begin{pmatrix} U_A \\ U_B \end{pmatrix} = \begin{pmatrix} I_0 \\ U_0/2R \end{pmatrix}$$



Idealis transformator



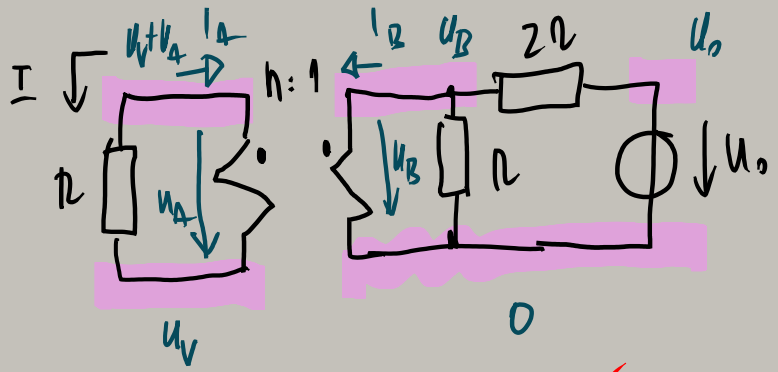
$$U_A = n \cdot U_B$$

$$I_B = -n \cdot I_A$$

nonenergibilas

$$U_A \cdot I_A + U_B \cdot I_B = U_A \cdot I_A + \frac{U_A}{n} \cdot (-n \cdot I_A) = 0$$

$-U_A \cdot I_A$



$$I = -I_A$$

ismeretlen: $U_A, U_B, I_A, I_B, U_v, I$

new to dy-
mont

$$I_A + \frac{U_v + U_A - U_v}{R} = 0$$

$$\frac{U_B - U_0}{2R} + \frac{U_B}{R} + I_B = 0$$

$$U_A = n \cdot U_B$$

$$I_B = -n \cdot I_A$$

$$\textcircled{1} U_A = -I_A \cdot R$$

$$3U_B + 2R I_B = U_0$$

$$U_A = n \cdot U_B$$

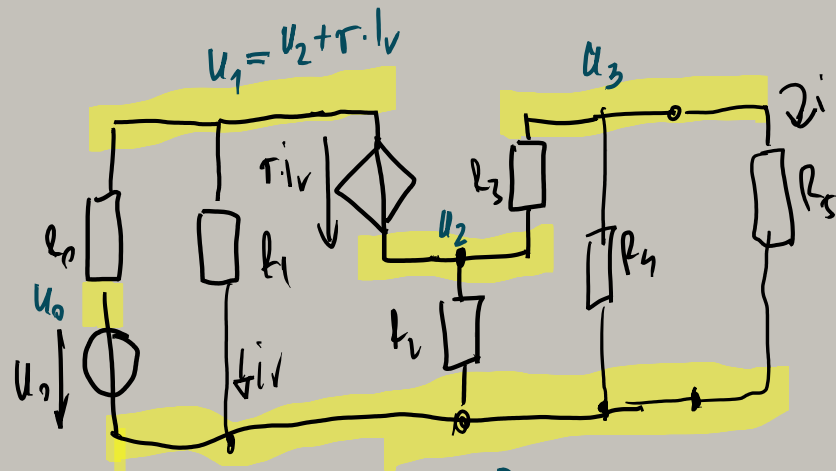
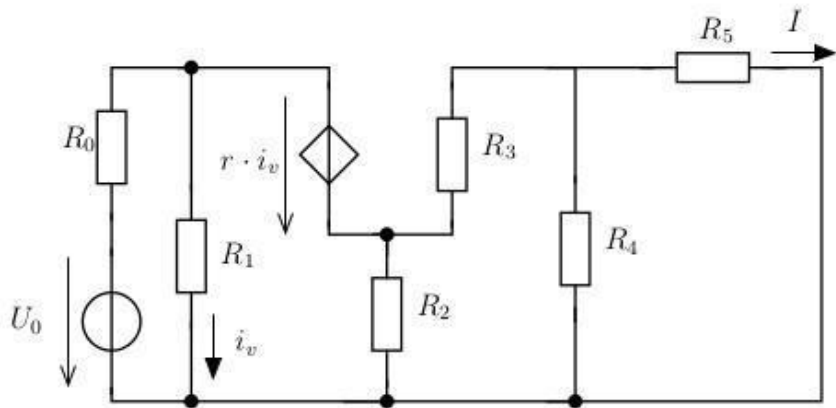
$$I_B = -n \cdot I_A$$

$$I = -I_A = \frac{U_0}{R} \cdot \frac{n}{3+2n^2}$$

$$3 \cdot \frac{1}{n} (-I_A \cdot R) + 2R \cdot (-n I_A) = U_0$$

$$(-I_A) \left(\frac{3R}{n} + n2R \right) = U_0$$

$$I_A = \frac{-U_0}{\frac{3R}{n} + n2R} = \frac{-U_0}{R} \cdot \frac{n}{3+2n^2}$$



$$1) \frac{u_2 + r \cdot i_v - u_0}{R_0} + \frac{u_2 + r \cdot i_v}{R_1} + \frac{u_2}{R_2} + \frac{u_2 - u_3}{R_3} = 0$$

$$2) \frac{u_3}{R_4} + \frac{u_3}{R_5} + \frac{u_3 - u_2}{R_2} = 0$$

$$3) i_v = \frac{u_2 + r \cdot i_v}{R_1}$$

ismeretlen: u_2, u_3, i_v

$$\begin{pmatrix} \frac{1}{R_0} + \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} & -\frac{1}{R_3} & \frac{r}{R_0} + \frac{r}{R_1} \\ -\frac{1}{R_3} & \frac{1}{R_2} + \frac{1}{R_4} + \frac{1}{R_5} & 0 \\ 1 & 0 & r - R_1 \end{pmatrix} \begin{pmatrix} u_2 \\ u_3 \\ i_v \end{pmatrix} = \begin{pmatrix} u_0/R_0 \\ 0 \\ 0 \end{pmatrix}$$