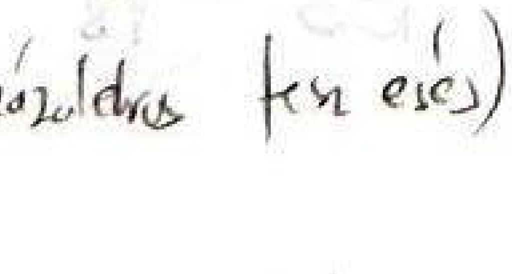
2007.03.22. csütörtök

XI. Előadás (6.hét)

Transzformátor

az óra tanulsága: drop: gyakorlatban 10%

$$\frac{\varepsilon}{100} = \frac{U_{rzf}}{U_{nf}} = \frac{\Delta U_{tr\,üzemi}}{U_{nf}} = \frac{I_{n1}}{I_z} = \frac{S_n}{S_z}$$

()

U_{n_1} / U_{n_2}

névleges primer fesz: U_{n1}

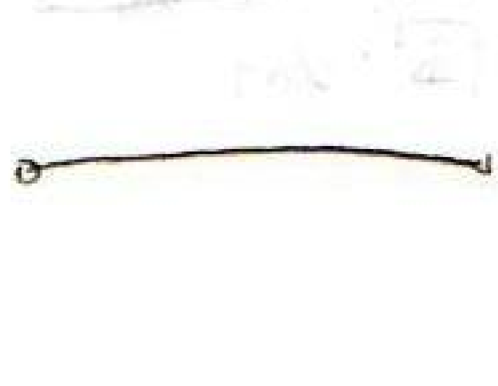
névleges szekunder fesz: U_{n_2}

áttétel: $\frac{U_{n1}}{U_{n2}} = \frac{N_1}{N_2} = \frac{I_{n2}}{I_{n1}}$

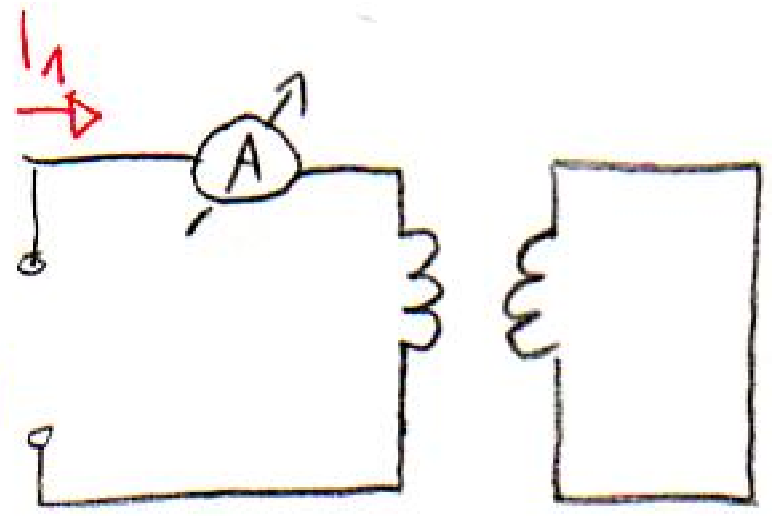
névl. telj: $S_n = S_{n_1} = S_{n_2} = \sqrt{3}\, U_{n1} \cdot I_{n1} = \sqrt{3}\, U_{n2} \cdot I_{n2}$

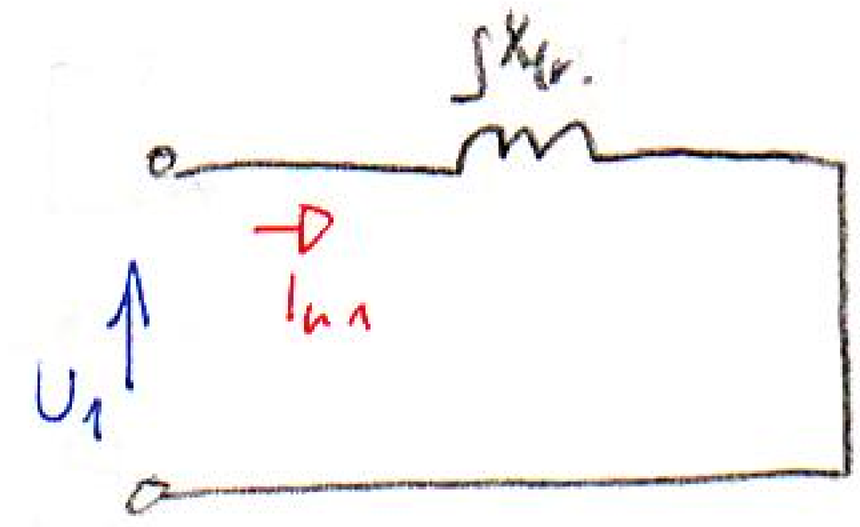
drop: ε [%] (százalékos fesz esés)

modell



Trafó reaktancia számítás:





$U_1 \uparrow \Rightarrow I_1 = I_{n1}$

$I_2 = I_{n2}$

① $$\varepsilon = \frac{U_1}{\frac{U_{n1}}{\sqrt{3}}} \cdot 100\% = \frac{I_{n1} \cdot X_{tr}}{\frac{U_{n1}}{\sqrt{3}}} \cdot 100\%$$

(U_1 → fázis; U_{n1} → vonali)

$$\Rightarrow X_{trafó_1} = \frac{\varepsilon}{100\%} \cdot \frac{U_{n1}/\sqrt{3}}{\frac{S_n}{\sqrt{3} \cdot U_{n1}}} = \frac{\varepsilon}{100\%} \cdot \frac{U_{n1}^2}{S_n}$$

($X_{trafó_1}$: primer ⚥, szek. ⚲ ; $\frac{S_n}{\sqrt{3} \cdot U_{n1}}$ = I_{n1})

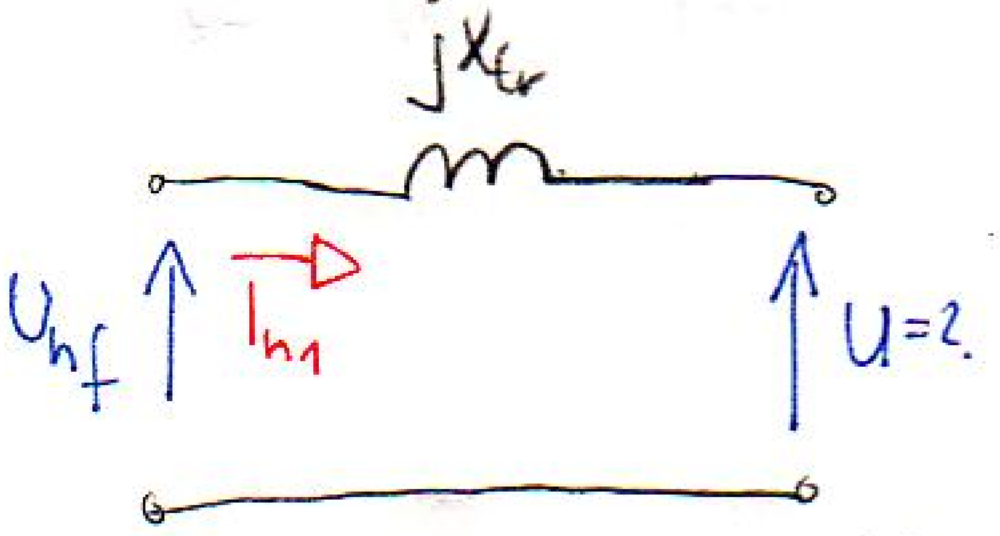
$$\Rightarrow X_{tr_2} = \frac{\varepsilon}{100\%} \cdot \frac{U_{n2}^2}{S_n}$$

(X_{tr_2}: primer ⚲, szek. ⚥)

$$\frac{X_{tr_1}}{X_{tr_2}} = \left(\frac{U_{n1}}{U_{n2}}\right)^2$$

$$\frac{\varepsilon}{100} = \frac{U_{rzf}}{U_{nf}}$$

② Trafó üzemi feszültség esés

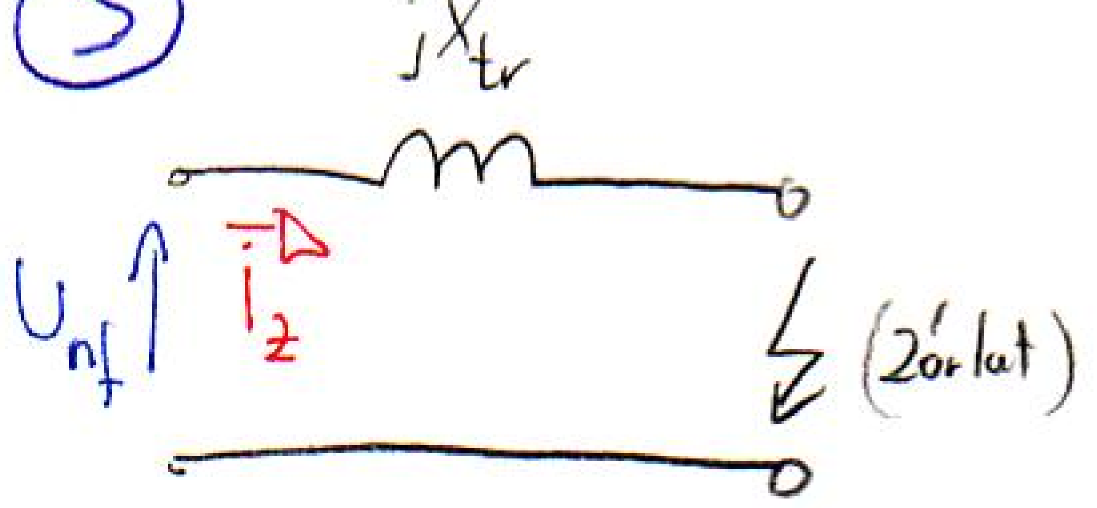


$$\Delta U_{tr} = I_{n1} \cdot X_{tr} = \frac{S_n}{\sqrt{3} \cdot U_{n1}} \cdot \frac{\varepsilon}{100} \cdot \frac{U_{n1}^2}{S_n} = \frac{\varepsilon}{100} \cdot \frac{U_{n1}}{\sqrt{3}}$$

($\frac{U_{n1}}{\sqrt{3}} = U_{nf}$)

$$\boxed{\frac{\varepsilon}{100} = \frac{\Delta U_{tr}}{U_{nf}}}$$

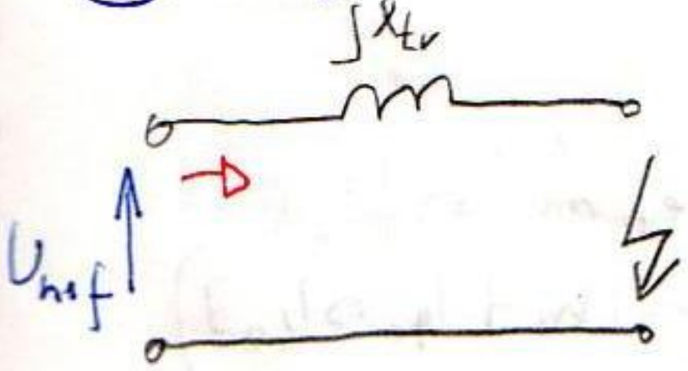
③



$$I_z = \frac{U_{nf}}{X_{tr}} = \frac{\frac{U_{n1}}{\sqrt{3}}}{\frac{\varepsilon}{100} \cdot \frac{U_{n1}^2}{S_n}} = \frac{100}{\varepsilon} \cdot \frac{\sqrt{3} \cdot U_{n1} \cdot I_{n1}}{\sqrt{3} \cdot U_{n1}}$$

$$\boxed{\frac{\varepsilon}{100} = \frac{I_{n1}}{I_z}}$$

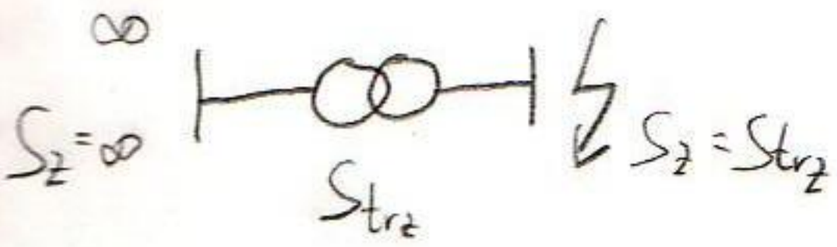
(4) S_{trz}



$$S_{trz} = \sqrt{3} \cdot U_{n1} \cdot I_z = \sqrt{3}\, U_{n1}\, \frac{\frac{U_{n1}}{\sqrt{3}}}{\frac{\varepsilon}{100} \cdot \frac{U_{n1}^2}{S_n}} = \frac{S_n}{\frac{\varepsilon}{100}}$$

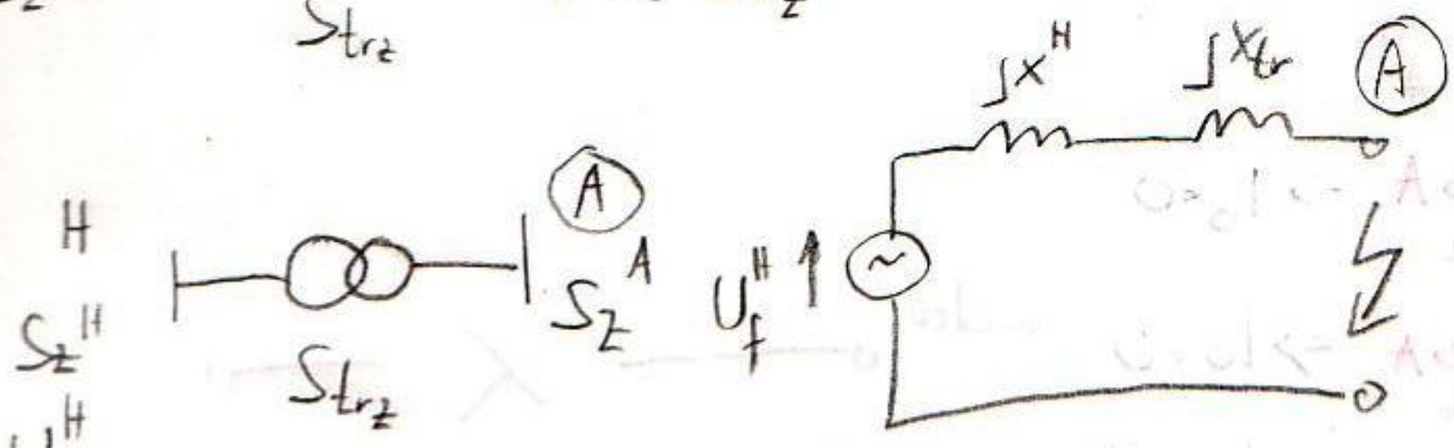
$$\boxed{\frac{\varepsilon}{100} = \frac{S_n}{S_z}}$$

⇒ mire jó?



H: hálózat

(A): A oldal



$$S_z^A = \sqrt{3}\, U_n\, I_z = \sqrt{3} \cdot U_n^H \cdot \frac{U_f^H}{X^H + X_{tr}}$$

$$X = \frac{U_n^{H\,2}}{S_z^H}$$

$$X_{tr} = \frac{\varepsilon}{100}\, \frac{U_{tr,n}^2}{S_n}$$

$$U_n^H \approx U_{trn}$$

$$\frac{1}{S_z^A} = \frac{1}{S_z^H} + \frac{1}{S_{z,tr}}$$

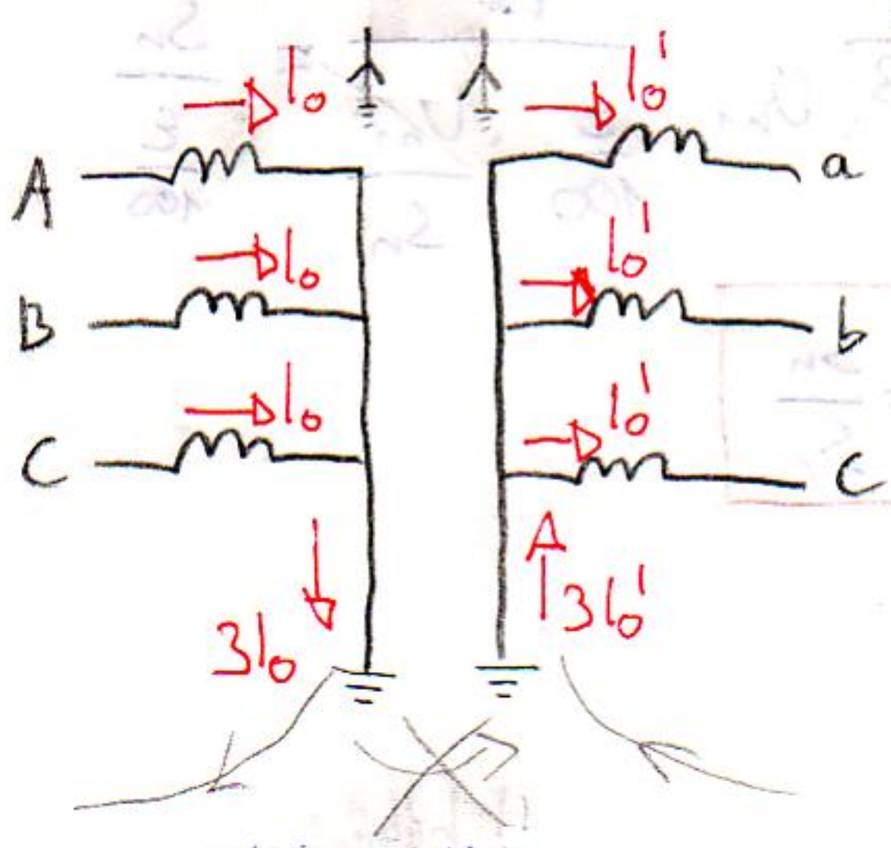
eddig pozitív (⊕) sorrendű modell,

a (⊖) sorrendű modell a forgógépekkel ellentétben megegyezik a (⊕) sorrendű modellel $X_{tr}^{⊕} = X_{tr}^{⊖}$

mi a helyzet a (⊙)-sorrendű modellel?

trafó zérussorrendi modell

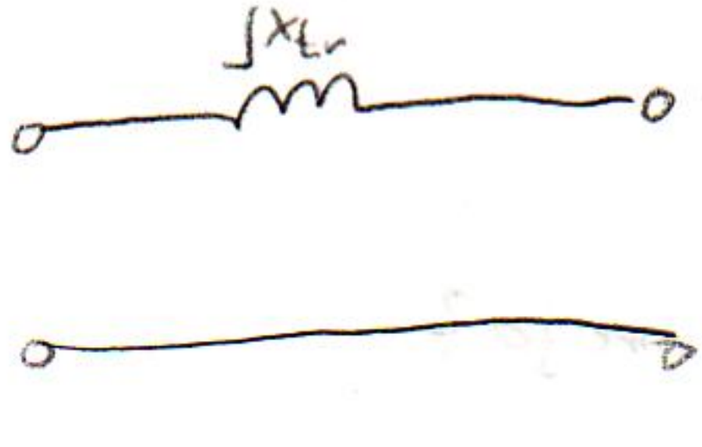
$$X_{tr}^{\oplus} = X_{tr}^{\ominus} \approx X_{tr}^{\odot}$$

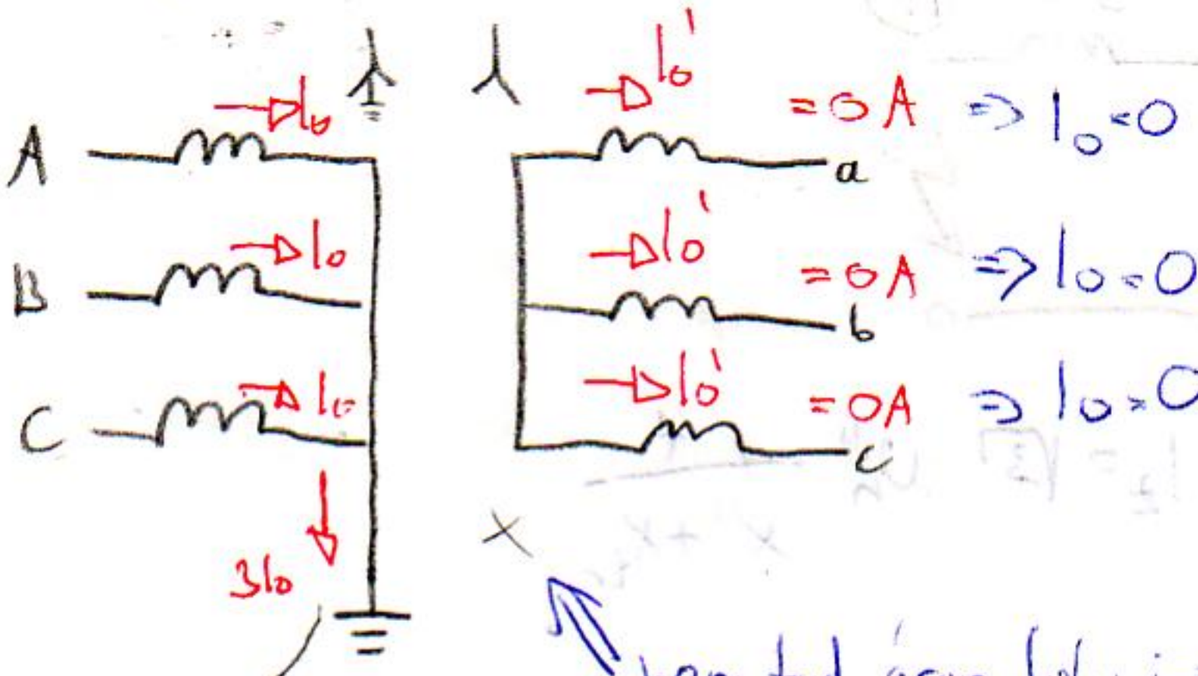


(foldelt csillag - foldelt csillag 3f-trafó)

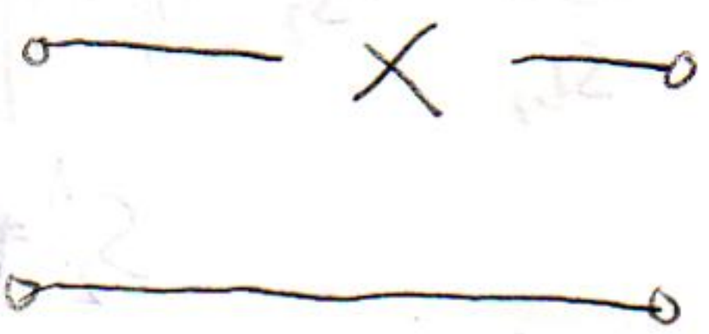
ha folyik pozitív áram => folyik szekunder áram (ha $\exists I_{10} \Rightarrow I_{20} \exists$)

modell



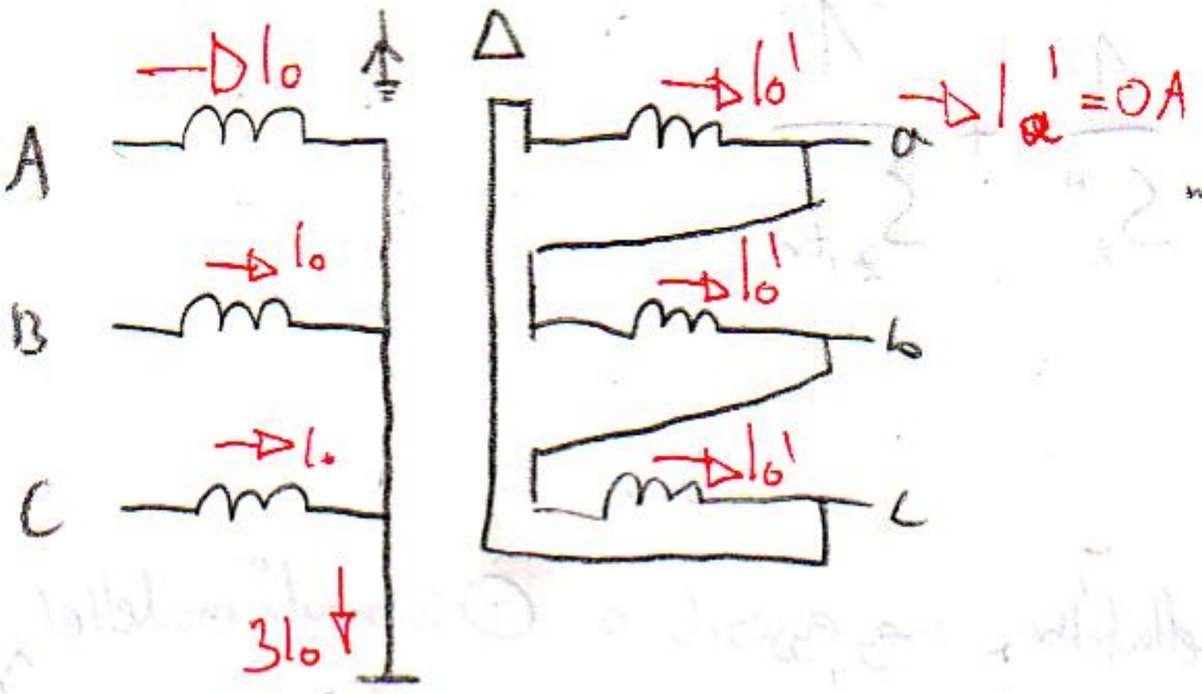


modell

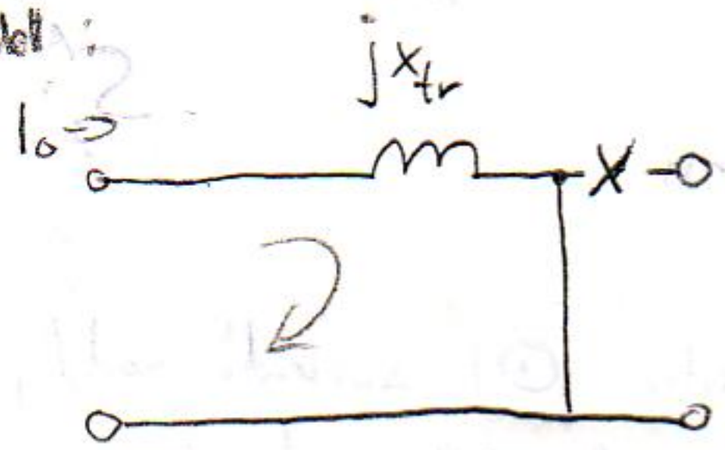


hen tud áron folyni $\Rightarrow I_0' = 0 \Rightarrow I_0 = 0 \Rightarrow$ helyettesítő modell = szakadás

(földelt csillag - szigetelt csillag 3f trafó)

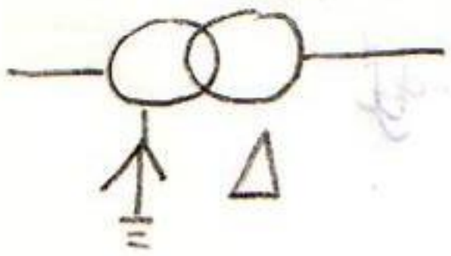


modell:



(földelt csillag - szigetelt delta Δ - trafó)

Kapcsolási csoport

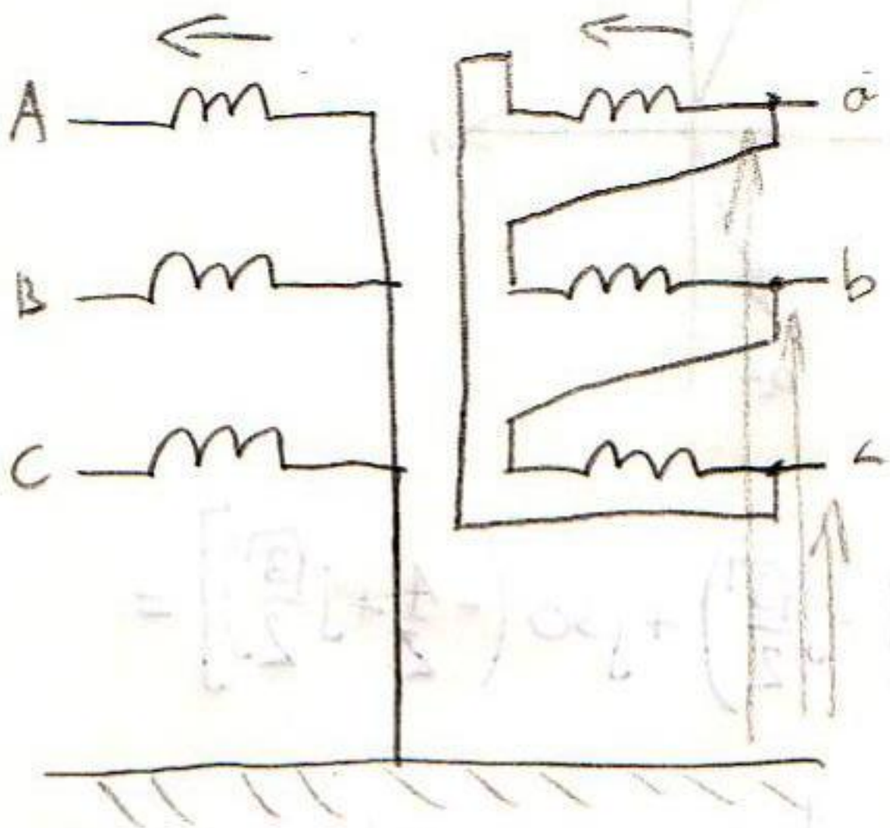


Yd11

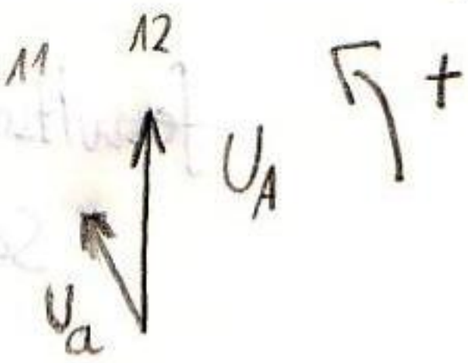
↗ nagyobb feszültség kapcsolása

↑ kisebb feszültség kapcsolása

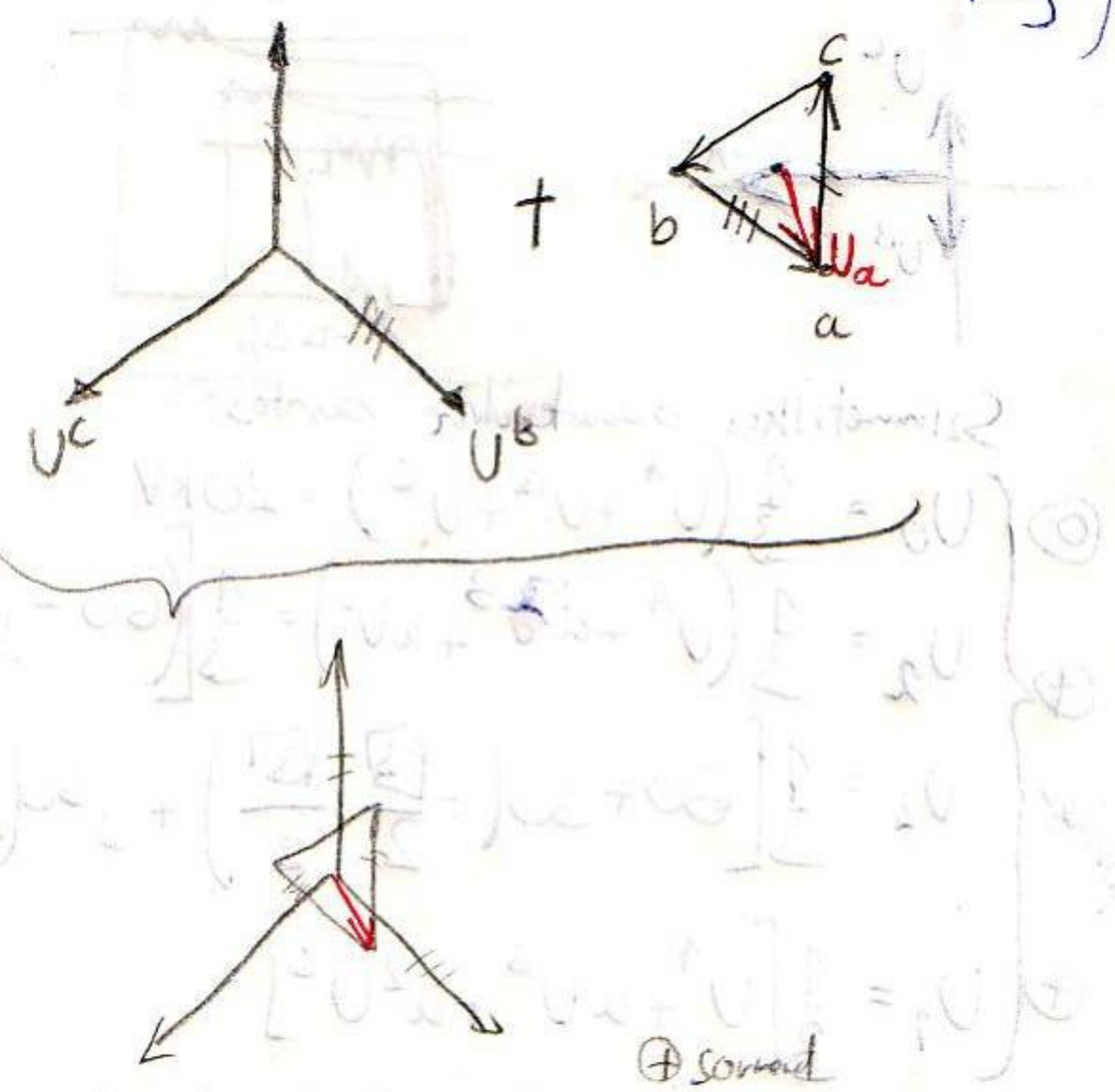
↖ 0...12 ~~1,4,8,10~~



⊕ sorrend!



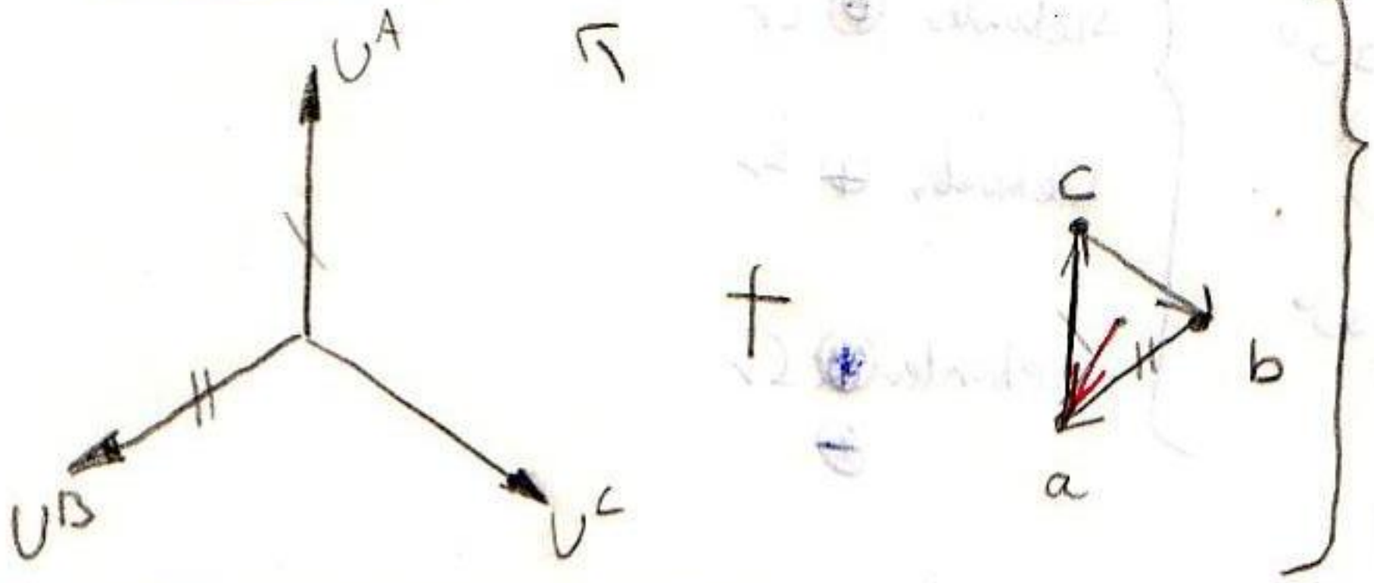
pozitív sorrend (kapcsolási sorrendet ebből adjuk meg)



⊕ sorrend

⇒ Yd5 (Y->d: -150°)

negatív sorrend:



⊖ sorrend

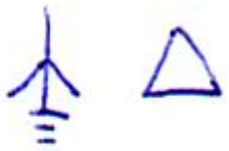
Y -> d: +150°

Zérus sorrendről itt nem beszélünk (Yd esetben) U_A-nak nincs köze U_a-hoz (Zérus sorrend csak Yy0 és Yy6-nál van)

de tovább is Yd5 marad, csak a fázistolás előjele változik a ⊕ sorrendhez képest

példa (U_{n1}) (U_{n2}) 120/36,75

Yd11

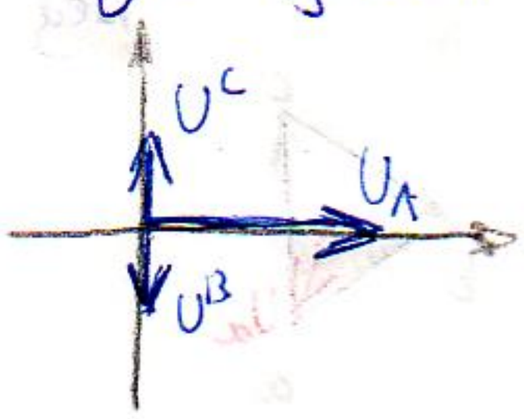


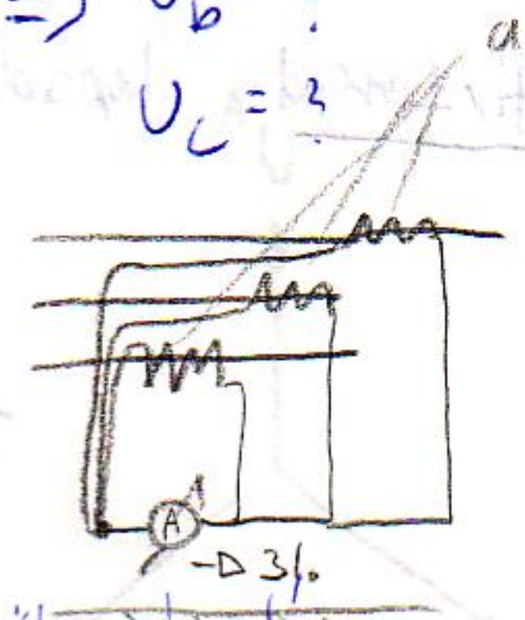
feszültség és áramok egymásnak fordulnak, se inp, se telj nem fordul!

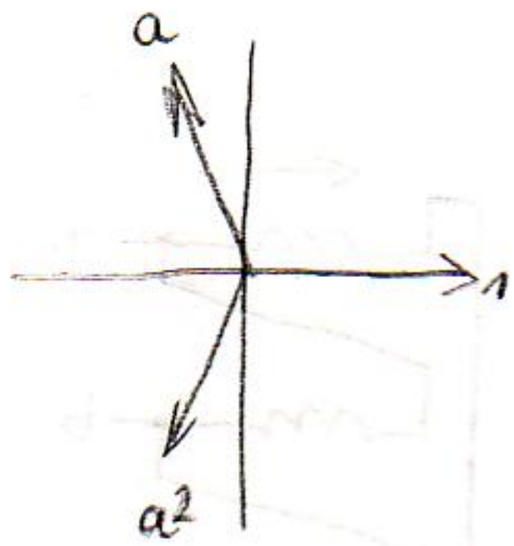
$U^A = 60kV$ $\quad U_a = ?$

$U^B = -j30kV$ $\quad \Rightarrow \quad U_b = ?$

$U^C = +j30kV$ $\quad U_c = ?$







Szimmetrikus összetevőkre bontás:

⊙ $U_0 = \frac{1}{3}(U^A + U^B + U^C) = 20kV$

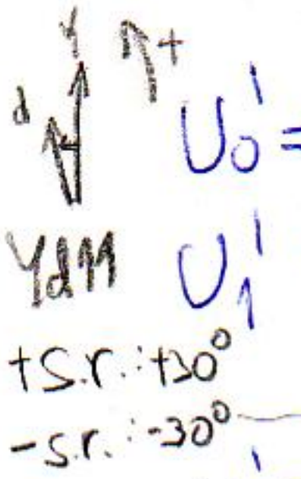
⊖ $U_2 = \frac{1}{3}(U^A + a^2 U^B + a U^C) = \frac{1}{3}\left[60 - j30\left(-\frac{1}{2} - j\frac{\sqrt{3}}{2}\right) + j30\left(-\frac{1}{2} + j\frac{\sqrt{3}}{2}\right)\right] =$

$= \frac{1}{3}\left[60 + 30\left(-\frac{\sqrt{3}}{2}\ \frac{\sqrt{3}}{2}\right) + j30\left(\frac{1}{2} - \frac{1}{2}\right)\right] = \frac{1}{3}(60 - 30\sqrt{3}) = 2{,}68kV$

primer

⊕ $U_1 = \frac{1}{3}\left[U^A + aU^B + a^2U^C\right] =$

$= \frac{1}{3}\left[60 + 30\sqrt{3} + \phi\right] = 37kV$



$U_0' = \phi$

$U_1' = 37kV \cdot \frac{36{,}75}{120} \cdot e^{j30°}$

$U_2' = 2{,}68kV \cdot \frac{36{,}75}{120} e^{-j30°}$

} Szekunder ⊕ sr

} Szekunder ⊖ Sr

$U_a = U_0' + U_1' + U_2'$

$U_b = U_0' + a^2 U_1' + a U_2'$

$U_c = U_0 + a U_1' + a^2 U_2'$

} fázis + szekunder feszek

$[T] = \begin{bmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{bmatrix}$ $\quad [T]^{-1} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & a & a^2 \\ 1 & a^2 & a \end{bmatrix}$

$U_{ab} = U_a - U_b$