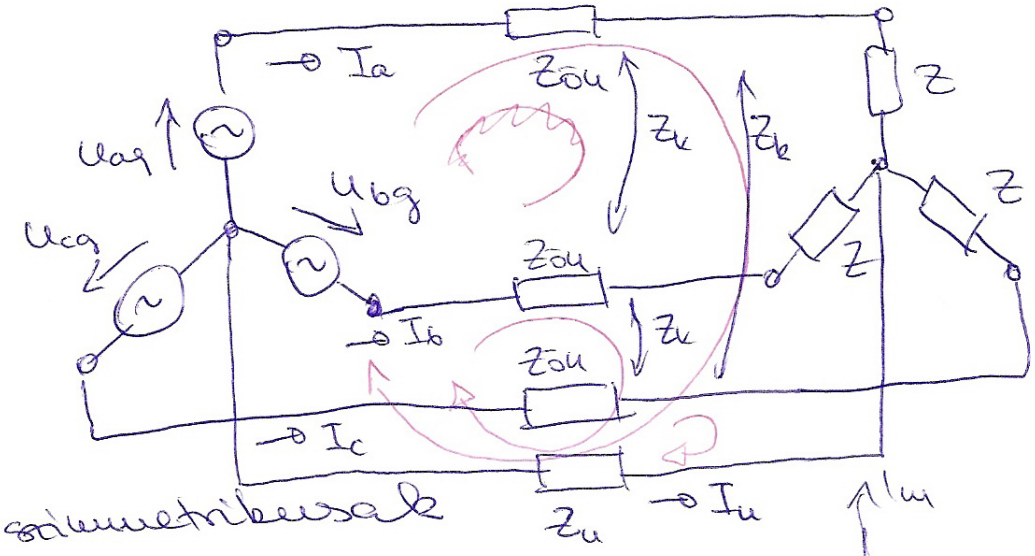
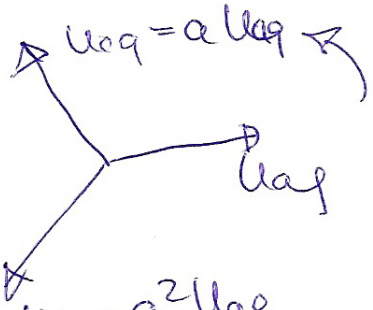
2009.02.24. Energetika gyak.

Generátor: 3 fázisú, szinkron

- üzemben 3 fázisú tekercselés, villamos
- forgórészben egyenáram
- turbinával azonos tengelyen

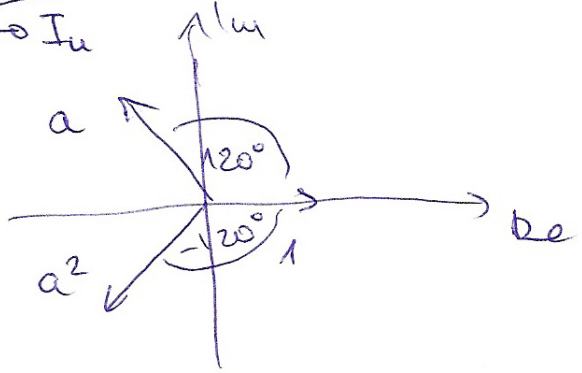
- egyszerűsített (kapcsolási) ábra





pozitív sorrendű

a, b, c



$a = e^{j120°}$

$a^2 = e^{j240°} = e^{-j120°} = aa$

$1 = a^3$

$1 + a + a^2 = 0$

$$I_a + I_b + I_c = -I_u$$

$$U_{aq} - I_a Z_{su} - I_b Z_k - I_c Z_k - I_a Z + I_u Z_u = \phi$$

$$a^2 U_{aq} - I_b Z_{su} - I_a Z_k - I_c Z_k - Z_b Z + I_u Z_u = \phi$$

$$a U_{aq} - I_c Z_{su} - I_b Z_k - I_a Z_k - I_c Z + I_u Z_u = \phi$$

$$\phi = Z_{su}(I_a + I_b + I_c) - Z_k 2 (I_a + I_b + I_c) - Z(I_a + I_b + I_c) + 3 Z_u I_u = \phi$$

$(I_a + I_b + I_c) = -I_u$ $\quad (I_a + I_b + I_c) = -I_u$ $\quad (I_a + I_b + I_c) = -I_u$

$$I_u [Z_{su} + 2Z_k + Z + 3Z_u] = \phi$$

$$\boxed{I_u = \phi}$$

$$U_{aq} - I_a (Z_{su} + Z) - Z_k (I_b + I_c) = \phi$$

$(I_b + I_c) = -I_a$

$$I_a + I_b + I_c = -I_u = \phi$$

$$U_{aq} - I_a (Z_{su} - Z_k + Z) = \phi$$

$$U_{aq} = I_a (\underbrace{Z_{su} - Z_k + Z}_{Z'})$$

$$I_a = \frac{U_{aq}}{Z'}$$

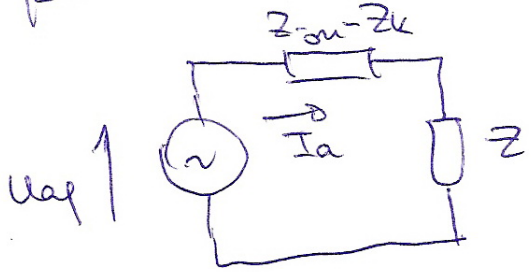
$$a^2 U_{aq} - I_b (Z_{su} + Z - Z_k) = \phi$$

$$I_b = \frac{a^2 U_{aq}}{Z'} = a^2 I_a$$

$$a U_{aq} - I_c (Z_{su} + Z - Z_k) = \phi$$

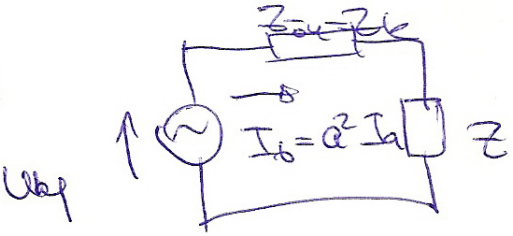
$$I_c = \frac{a U_{aq}}{Z'} = a I_a$$

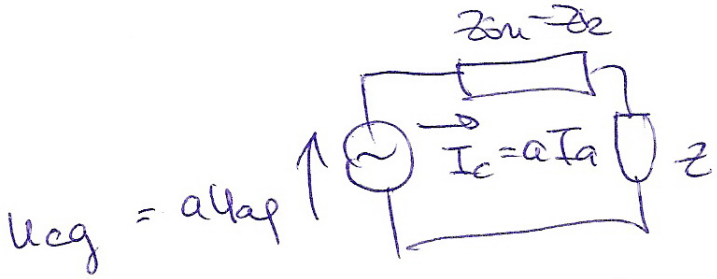
$$\boxed{\begin{aligned} I_b &= a^2 I_a \\ I_c &= a I_a \end{aligned}}$$

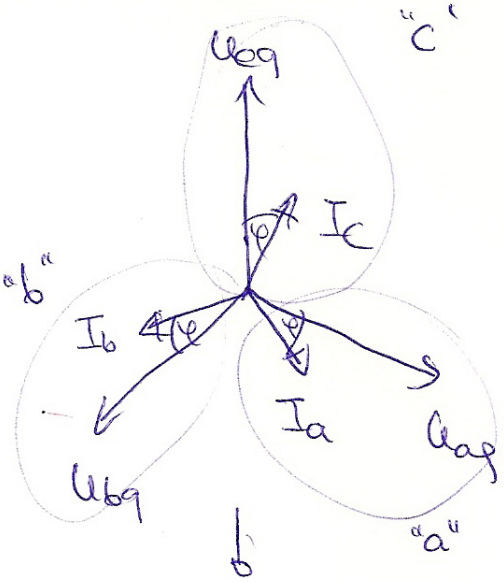


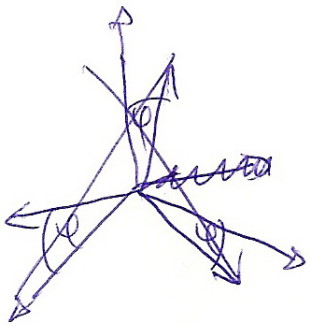
$$U_{aq} = I_a Z'$$

$U_{bq} = a^2 U_{aq}$



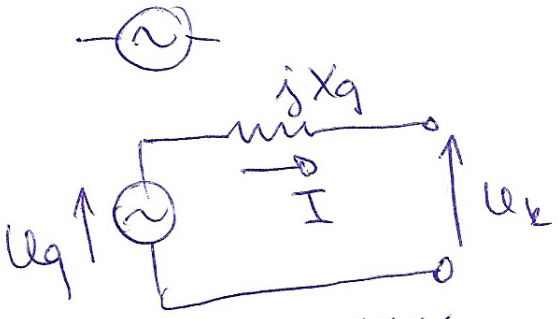






Szimmetrikus rendszereknél elég az egyik fázist vizsgálni!

Generátor



U_u [kV] vonali!

S_u [MVA] 3 fázisú ($S_{au} + S_{bu} + S_{cu}$)

X [%]

$$X_q = \frac{X\,\%}{100} \frac{U_u^2}{S_u}$$

kV / MVA / Ω

$X_q \ll X_q$

$$U_k \approx \frac{U_u}{\sqrt{3}}$$

minden feszültség, fázisfeszültség!

$$S_u = \sqrt{3}\, U_u I_u$$

X_d - szinkron reaktancia (150 - 300 %)

X' - tranziens reaktancia (15 - 30 %)

X'' - szubtranziens reaktancia (8 - 20 %)

↓ dinamikus esetnél → határesetnél

$U_q : I_q$ határozza meg (gerjesztő áram)

F

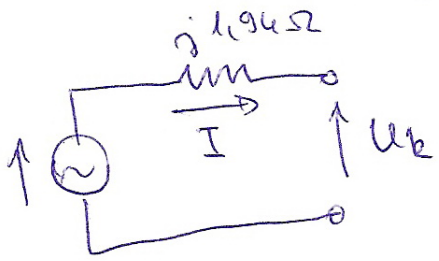
$U_u = 15{,}75\,kV$

$S_u = 256\,MVA$

$X = 200\,\%$

$$I_u = ? = \frac{S_u}{\sqrt{3}\,U_u} = \frac{256}{\sqrt{3}\,15{,}75} = 9{,}38\,kA$$

$$X^{\Omega} = ? = \frac{200}{100}\,\frac{15{,}75^2}{256} = \frac{X^{\%}}{100} \cdot \frac{U_u^2}{S_u} = 1{,}94\,\Omega$$



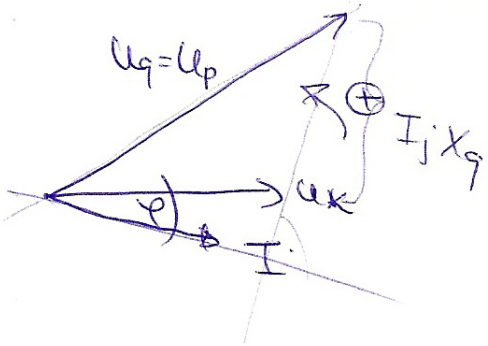
• legyen:

$$U_k = \frac{U_u}{\sqrt{3}}$$

induktív jellegű

$$I = I_u(\cos\varphi - j\sin\varphi)$$

$$\cos\varphi = 0{,}9 \rightarrow \sin\varphi = 0{,}436$$



$U_q = ?$

$S_k = ? = P_k + jQ_k$

$$I = 9{,}38(0{,}9 - j\,0{,}436) = (8{,}44 - j\,4{,}1)\,kA$$

$$S_k = 3\,U_k\,I^* = 3\,\frac{15{,}75}{\sqrt{3}}(8{,}44 + j\,4{,}1) = (230 + j\,112)\,MVA \Rightarrow 256 = |S_k|$$

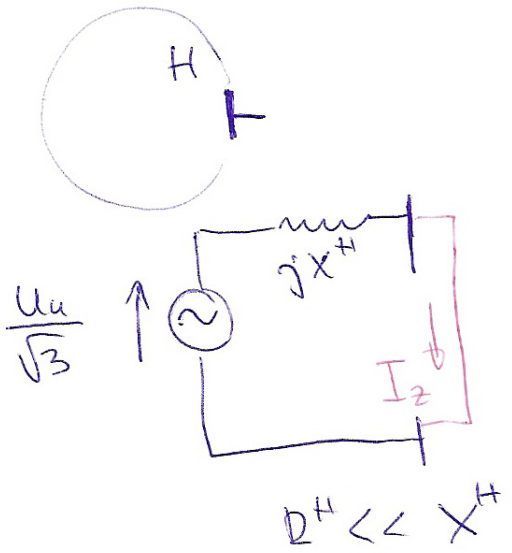
$Q_k = 112\,Mvar$

$$U_{eq} = U_2 + j I X_q = \frac{15{,}75}{\sqrt{3}} + j1{,}94(8{,}44 - j4{,}1) =$$

(fázisfeszültség)

$$= 17 + j16{,}4\,kV = 23{,}6\,kV \angle 44°$$

Nagy hálózat (táp, nagyállás)



U_u [kV] vonali

S_z [MVA] 3fázisú zárlati

$$S_z = \sqrt{3}\, U_u\, I_z =$$

$$= \sqrt{3}\, U_u \frac{U_u}{\sqrt{3}\, X^H} = \frac{U_u^2}{X^H}$$

$$X^H = \frac{U_u^2}{S_z}$$

- ha $S_z \cong \infty$ ⇒ végtelen hálózat