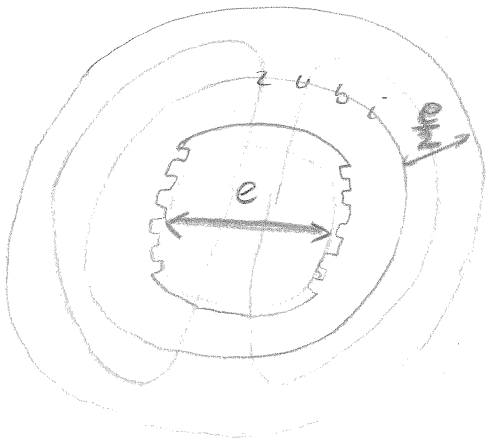
10. 3. 2015.

DINAMIKA INDUSTRIJSKIH SUSTAVA

1. auditorne



$$\delta = \frac{1}{2}\,\frac{A}{B_\delta}\,\frac{\tau_p}{X_d} = \frac{1}{2}\,\frac{4}{B_\delta}\,\frac{D_v/\pi}{2p X_d}$$

TG $\quad \delta \approx 10\ cm$

HG $\quad \delta \approx$ mm

manji X_d → veća stabilnost

veći X_d → manja struja kratkog spoja

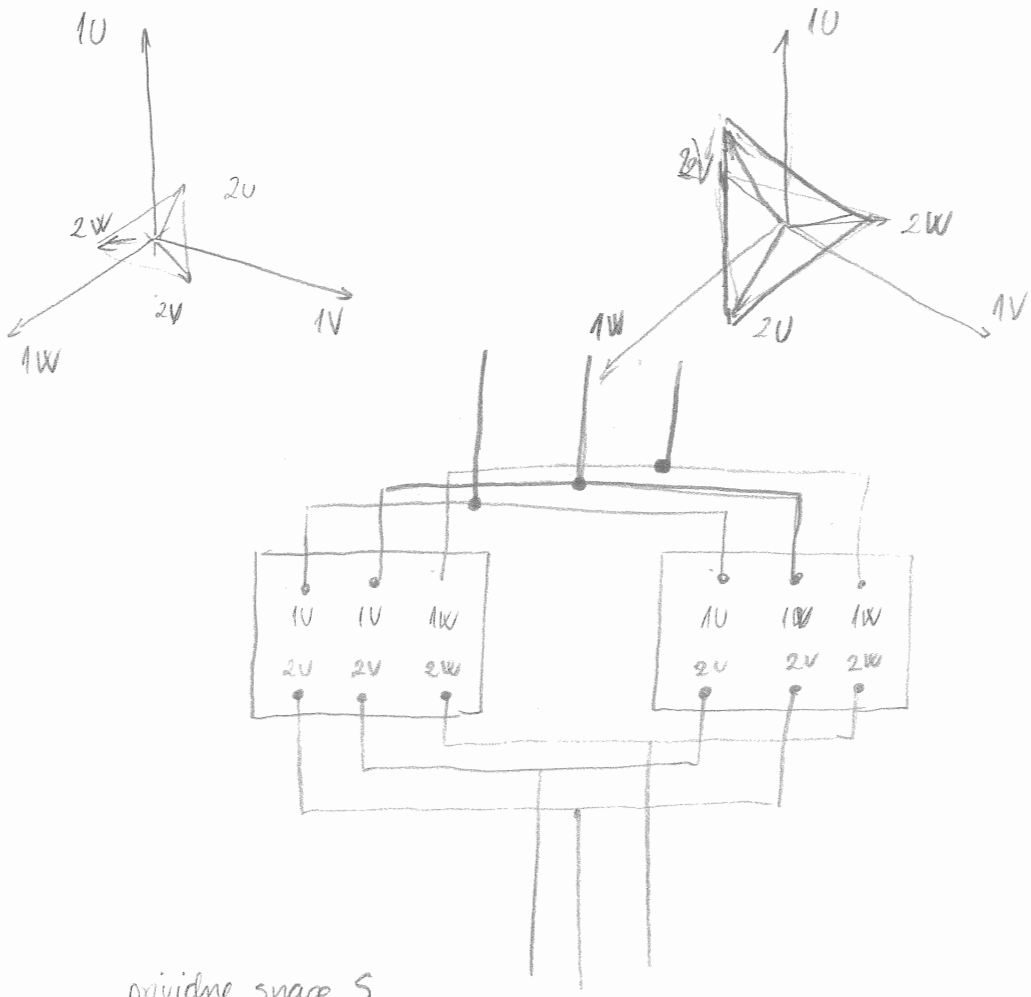
<u>Zad</u> 3. trafoa u paraleli imaju sl. podatke:

1.	$S_n = 150\,kVA$	$u_k = 3.5\,\%$	$P_0 = 450\,W$	$P_t = 1600\,W$	10/0.4kV
2.	$S_n = 125\,kVA$	$u_k = 4\,\%$	$P_0 = 350\,W$	$P_t = 1200\,W$	Yd7
3.	$S_n = 100\,kVA$	$u_k = 4.5\,\%$	$P_0 = 280\,W$	$P_t = 900\,W$	

a) ako su sva tri traf. uklj. a 1 preopterećen 10%, kolikom prividnu snagu prenose trafoi i koji je preopterećen

b) koliko je dozv. opt. i korisnost η ove grupe pri $\cos\varphi = 1$

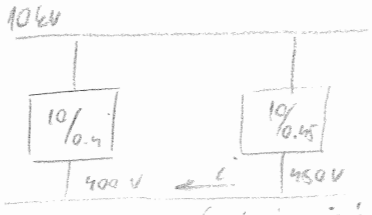
Yd1



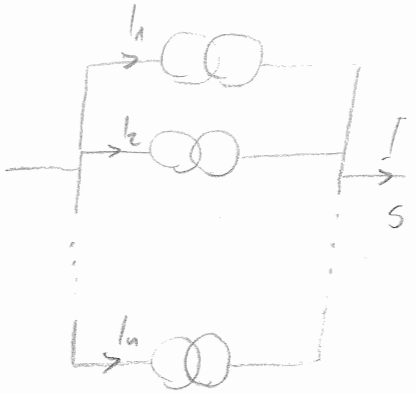
prividne snage S,

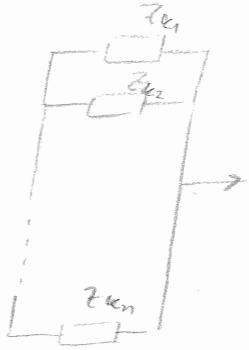
- uz različite $\frac{Q}{X}$ se mijenja → različito opterećenje trafoa

- isti prijenosni omjeri



Gustnja izjednačenja





$$\frac{I_{k1}}{X_{k1}} \simeq \frac{I_{k2}}{X_{k2}} \simeq \frac{I_{kn}}{X_{kn}}$$

$$I_1 \cdot Z_{k1} = I_2 \cdot Z_{k2} = I_n \cdot Z_{kn} = I \cdot Z_k$$

$$Z_{ki} = \frac{U_n^2}{S_{ni}} \cdot \frac{u_{ki}}{100}$$

II.

$$I = I_1 + I_2 + \dots + I_v$$

$$z_{ki} = \frac{U_n^2}{S_{ni}} \frac{u_{ki}}{100}$$

$$\frac{I_v}{I} = \frac{S_v}{S} = \frac{\frac{1}{z_{kv}}}{\frac{1}{z_k}} = \frac{\frac{100}{U_n^2}}{\frac{100}{U_n^2}} \frac{\frac{S_{nv}}{U_{kv}}}{\left(\sum \frac{S_{ni}}{U_{ki}}\right)}$$

$$\frac{S_v}{S} = \frac{S_{nv}}{U_{kv}\left(\sum \frac{S_{ni}}{U_{ki}}\right)}$$

$$\frac{S_v}{S_{nv}} = \alpha = \frac{S}{U_{kv}\left(\sum \frac{S_{ni}}{U_{ki}}\right)}$$

↓ faktor opterećenja pojedinog trafoa

1: $\alpha = 1.1 \rightarrow S = 370,87\ kVA$

$$\eta = \frac{\alpha S_n \cos\varphi - P_0 - \alpha^2 P_k}{\alpha S_n \cos\varphi} = 98.77\%$$

$$= 1 - \frac{P_{01} + \alpha_1^2 P_{k1} + P_{02} + \alpha_2^2 \cdot P_{k2} + \dots}{S_d \cdot \cos\varphi}$$

↳ dopuštena snaga koju prenosimo

III.

17. 3. 2015.

DIS

- auditorne 2

① TRAFO

$S = 0.8\ S_n$ hladan

$t = 1.4\,h$

↓ topliji $\Delta T = 30\ K$

konačno $\Delta T_m = 60K$ (∞ vrijeme)

$P_0 = 2{,}6\ kW$

$P_t = 9{,}1\ kW$

a) $\tau = ?$ ako se promatra kao homogeno tijelo

b) ΔT pri nazivnom teretu

c) hladno $\xrightarrow{4h,\ nazivno}$ T_1 $\xrightarrow{24\ \ 50\%\ prazt}$ T_2

$\Delta T = ?$, $T_2 = ?$

$t = ?$ → da se ohladi do T_1

d) $\vartheta_{sr} = 110\ °C$

koliko mu se skraćuje predviđeni živ. vijek od 15 god.

$\vartheta_{max} = 100\ °C$

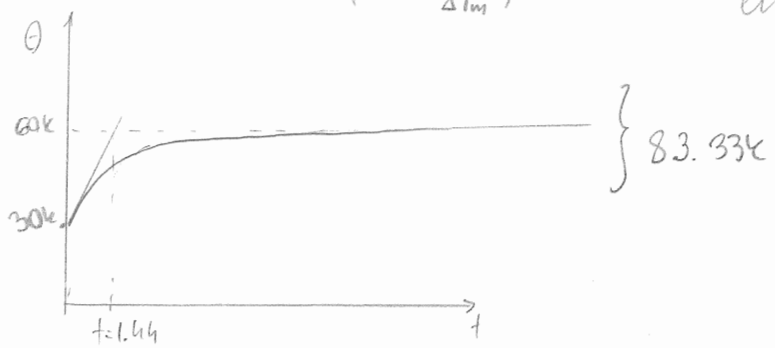
$\lambda = 6\ °C$

~~Rj~~

$$\vartheta = \vartheta_0 + (\vartheta_m - \vartheta_0)(1 - e^{-t/\tau})$$

a) $\Delta T = \Delta T_m (1 - e^{-t/\tau})$

$$\Rightarrow \tau = -\frac{t}{\ln\left(1 - \frac{\Delta T}{\Delta T_m}\right)} = -\frac{1.4}{\ln\left(1 - \frac{30}{60}\right)} = 2{,}024$$



IV

$$\frac{\vartheta_{1m}}{\vartheta_{mn}} = \frac{P_0 + \alpha_1^2 P_t}{P_0 + P_t} \Rightarrow \Delta T_{mn} = \Delta T_1 \cdot \frac{P_0 + P_t}{P_0 + \alpha_1^2 P_t}$$

$$\Delta T_{mn} = 60 \cdot \frac{2,6 + 9,1}{2,6 + 0.8^2 \cdot 9.1}$$

c) $\Delta T_1 = \Delta T_{mn}\left(1 - e^{-t/\tau}\right) = 83.33\left(1 - e^{-\frac{4}{2,02}}\right) = 71.83K$

$$\Delta T_{2m} = \Delta T_{mn} \cdot \frac{P_0 + \alpha^2 P_t}{P_0 + P_t} = 83.33 \cdot \frac{2,6 + 1.5^2 \cdot 9.1}{2.6 + 9,1} = 164.35K$$

$$\vartheta_2 = \vartheta_0 + (\vartheta_{2m} - \vartheta_0)\left(1 - e^{-t/\tau}\right) = 71,83 + (164,35 - 71,83)\left(1 - e^{-\frac{2}{2,02}}\right)$$

$$= 129,98K$$

$$t(°C) = 160°C$$

$$\vartheta = \vartheta_1 e^{-t/\tau}$$

$$t = -\tau \cdot \ln\left(\frac{\vartheta}{\vartheta_1}\right) = -2,02 \cdot \ln\left(\frac{83.33}{129.98}\right)$$

$$\boxed{t = 0.94}$$

d) $z = z_0 \cdot 2^{-\frac{\theta - \theta_0}{\Delta}}$; $\Delta = \lambda = 6°C$

$$z = 15 \cdot 2^{-\frac{110 - 100}{6}}$$

$$z = 4,72g \qquad \boxed{\Delta z = 68,75\%}$$

V

(2) Za mrežu na slici:

a) poč. str. $I_{3k} = ?$

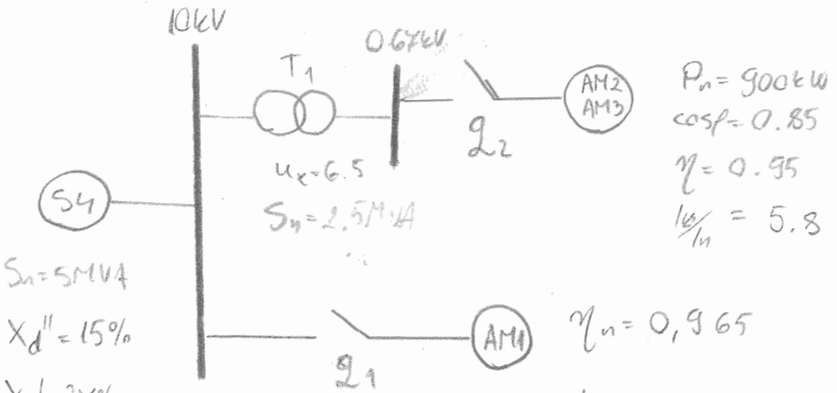
sabirnica : 0.67 kV

→ prekidači Q_1 i Q_2 isključeni

→ $S_{3k} = ?$

b) Q_1 i Q_2 uključeni

$u_k = ?$ ∩ $I_{k_{poč}} \leq 22\ kA$

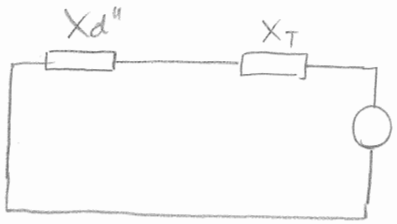


a) $X_d'' = \frac{X_{d\%}''}{100} \cdot z_b \cdot \frac{1}{i^2} = \frac{x_d''}{100} \cdot \frac{U_n^2}{S_n} \cdot \frac{1}{\left(\frac{U_n}{U_{fault}}\right)^2} = \frac{15}{100} \cdot \frac{(10 \cdot 10^3)^2}{5 \cdot 10^6} \cdot \left(\frac{0.67 \cdot 10^3}{10 \cdot 10^3}\right)^2$

$= 0.0135\Omega$

$X_T = \frac{x_k}{100} \cdot z_b = \frac{u_k}{100} \cdot \frac{U_n^2}{S_n} = \frac{6,5}{100} \cdot \frac{(0.67 \cdot 10^3)^2}{2.5 \cdot 10^6} = 0,0135\Omega$

$= 0.0117\Omega$



$\frac{c \cdot U_n}{\sqrt{3}}$, $c = 1,05$

$z_{k3} = X_T + X_d'' = 0.0251\Omega$

18.75MVA

VI $I_{k3} = \frac{c \cdot U_{fault}}{\sqrt{3}\ z_{uk}} = 16,15kA$, $S_3 = \sqrt{3}\,U \cdot I_3 = \sqrt{3} \cdot 670 \cdot 16.15$

b)

$$X_{m1} = \frac{1}{\frac{I_{k3}}{I_n}} \cdot z_0 \cdot \frac{1}{i^2} = \frac{1}{\frac{I_{k3}}{I_n}} \cdot \frac{U_n^2}{S_n} \cdot \frac{U_f^2}{U_n^2} = \frac{I_n}{I_{ks}} \cdot \frac{U_n^2}{\frac{P_n}{\cos\varphi \cdot \eta}} \cdot \frac{U_f^2}{U_n^2}$$

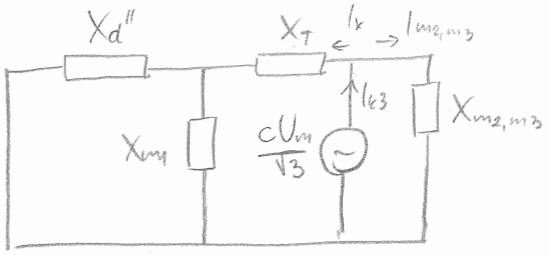
$$= \frac{1}{4.9} \cdot \frac{0.58 \cdot 0.965}{1.5 \cdot 10^6} \cdot 670^2$$

$$= 0.0519\,\Omega$$

$$I_k = I_n \cdot \frac{U_n}{U_k}$$

$$X_{m2,m3} = \frac{1}{2} X_{m2} = \frac{1}{2} X_{m3}$$

$$= \frac{I_n}{I_{ks}} \cdot \frac{\cos\varphi \cdot \eta_n}{P_n} \cdot U_f^2 = \frac{1}{58} \cdot \frac{0.85 \cdot 0.95}{900 \cdot 10^3} \cdot 670^2 = \overbrace{0.0347 \cdot 2}^{X''_{m2,m3}}\,\Omega$$



$$I_{k3} = I_x + I_{m2,m3}$$

$$I_x = 22 \cdot 10^3 - \frac{1,05 \cdot 670}{\sqrt{3} \cdot 0.0347}$$

$$= 10,302\,kA$$

$$X_x = \frac{cU_n}{\sqrt{3} \cdot I_x} = \frac{1,05 \cdot 670}{\sqrt{3} \cdot 10,302 \cdot 10^3} = 0.0394\,\Omega$$

$$X_x = X_T + X_d'' \| X_{m1} = X_T + \frac{X_d'' \cdot X_{m1}}{X_d'' + X_{m1}}$$

$$X_T = X_x - X_d'' \| X_{m1} = 0.0288$$

$$X_T = \frac{X_k}{100} \cdot z_0 \Rightarrow u_k = X_T \cdot \frac{S_n}{U_n^2} \cdot 100 = 0.0288 \cdot \frac{2.5\,10^6}{670^2} 100$$

$$\boxed{u_k = 16,04\,\%}$$

31. 3. 2015.

DIS

-auditorne 5

① Za 2-polni TG $S_n = 5\,MVA$, $J = 190$ [neporznata njemna jedinica]

meh. vrem konst i konst. kromosti ?

Na temelju dobiv. iznosa zakljuciti J jedinicu ?

Kolika je E_{kin} u rotoru pri n_s ?

$S_n = 5\,MVA$

$J = 190$ [kgm^2 ili tm^2]

$T_m = ?$

$H = ?$

$$J \frac{d\omega_m}{dt} = M_u \Big/ \frac{1}{M_B}$$

$$\frac{J}{M_B} \cdot \frac{d\left(\frac{\omega}{p}\right)}{dt} = \frac{M_u}{M_B}$$

$$\frac{J}{M_B} \cdot \frac{\omega_B}{p} \cdot \frac{d\left(\frac{\omega}{\omega_B}\right)}{dt} = \frac{M_u}{M_B} \quad ; \quad \omega_B = \omega_n = \omega_s = 2\pi f$$

$$\left(\frac{J}{M_B} \cdot \frac{\omega_B}{p}\right) \cdot \frac{d\omega_{p.u.}}{dt} = M_{p.u.} \quad ; \quad M_B = \frac{P_B}{\omega_B} \cdot p$$

mehanicka konstanta T_m

$$T_M = \frac{J}{P_B} \cdot \left(\frac{\omega_B}{p}\right)^2 \quad ; \quad P_B = \frac{3}{2} U_B \cdot I_B = \frac{3}{2} \cdot \underbrace{\sqrt{2}\,U_{fn}}_{U_B} \cdot \underbrace{\sqrt{2}\,I_{fn}}_{I_B}$$

$$T_m = J \frac{\omega_{mB}^2}{S_n} \Bigg|_{p=1 \quad \omega_{mB} = \omega_B = \omega_n} \qquad P_b = 3\,U_{fn} \cdot I_{fn}$$

$$= 3 \cdot \frac{U_{en}}{\sqrt{3}} \cdot I_{fn} = \sqrt{3} \cdot U \cdot I = S$$

① $J = 190\,kgm^2$

$$T_m = 190 \cdot \left(\frac{3000\pi}{\frac{30}{5 \cdot 10^6}}\right)^2 = 3,755\,s$$

② ~~$J = 190\,tm^2$~~

$T_M = 3750,45\,s$

VIII

$$H = \frac{E_k}{P_B} = \frac{\frac{1}{2} J \omega_{mB}^2}{P_B} = \frac{1}{2} \frac{J}{M_B} \frac{\omega_B}{P} = \frac{1}{2} T_m$$

$T_m \rightarrow$ za konstantni moment

$H \rightarrow$ za konstantnu snagu

$$T_m = 2H \rightarrow H = 1,875 s$$

$$E_k = \frac{1}{2} J \omega_m^2 = \frac{1}{2} \cdot 190 \cdot \left(\frac{2000\pi}{30}\right)^2$$

$$E_k = 9,38 MJ$$

(2.) Nacrtaj P - Q ovisnost o δ, 12 - polni sink. stroj rad na krutu mrežu $I_f = I_{fn}$. Odredi nazivne radne točke za slučaj gen. i mot. režima rada.

$S_n = 35 MVA$

$f = 50 Hz$

$\cos\varphi_n = 0,9$

$U_n = 10,5 kV$

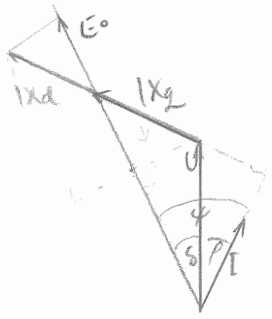
$X_d = 140\%$

$X_q = 85\%$

nazivna r. t.

$P_n = S_n \cdot \cos\varphi_n = 35 \cdot 0,9 = 31,5 MW$

$Q = S_n \cdot \cos\varphi = 15,26 MVAr$



$$tg\,\psi = \frac{I_n X_q + U_n \sin\varphi}{U_n \cos\varphi} = 1,4259$$

$\psi = 55°$

$\Rightarrow \delta = 29,16°$

$E_0 = U_n \cdot \cos\delta_n + I_n \cdot X_d \cdot \sin\psi$

$= 2,05 p.u$

$$P = \frac{E_0 \cdot U}{X_d} \sin\delta + \frac{U^2}{2}\left(\frac{1}{X_q} - \frac{1}{X_d}\right) \sin 2\delta$$

$$\frac{\partial P}{\partial \delta} = \frac{E_0 U}{X_d} \cos\delta + U^2\left(\frac{1}{X_q} - \frac{1}{X_d}\right) \cos 2\delta = 0 \; ; \quad \cos 2\delta = 2\cos^2\delta - 1$$

$\cos\delta_1 = 0,273 \Rightarrow \delta_{pr} = 74,16°$

~~$\cos\delta_2 = 1,83$~~

$Q_{max} = 35 \cdot 0,75 = 26,25 MVAr$

IX

(3) 3-fazni Sin. gen. podaci:

$S_n = 10\ MVA$

$U_n = 10{,}5\ kV$

$n_n = 375\ o/min$

$\cos\varphi_n = 0{,}8$

$X_d = 100\ \%$

$X_q = 50\ \%$

Što će se dog. ako stroja uz U_n i f_n priopteremo $S = 8\ MVA$ i $\cos\varphi = 0{,}6$ ind prekinemo uzbudu

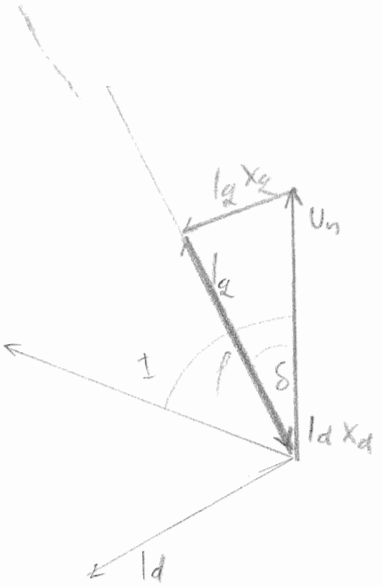
$$P = S\cdot\cos\varphi = 8\cdot 0{,}6 = 4{,}8\ MW$$

$$P = \frac{E_0 U}{X_d}\sin\delta + \frac{U^2}{2}\left(\frac{1}{X_q} - \frac{1}{X_d}\right)\sin 2\delta$$

$\frac{E_0 U}{X_d}\sin\delta \Rightarrow 0$

$$\Rightarrow \sin 2\delta = P\cdot\frac{1}{\frac{U^2}{2}\cdot\left(\frac{1}{X_q} - \frac{1}{X_d}\right)} = 0{,}96$$

$$\boxed{\delta = 36{,}87^\circ}$$



$$Q = \frac{UE_0}{X_d}\cos\delta + \frac{U^2}{2}\left(\frac{1}{X_q} - \frac{1}{X_q}\right)\cos 2\delta + \frac{U^2}{2}\left(\frac{1}{X_q} + \frac{1}{X_d}\right)$$

$$= -1{,}36\ p.u. = -13.6\ MVA_r$$

$$I_d X_d = U_n\cos\delta$$

$$I_d = 0{,}8\ p.u.$$

$$tg\,\delta = \frac{I_q X_q}{I_d X_d} \Rightarrow I_q = \frac{I_d X_d}{X_q}\,tg\,\delta$$

$$I_q = 1{,}2\ p.u.$$

$$I = \sqrt{0{,}8^2 + 1{,}2^2} = 1{,}44\ p.u.$$

$$S = 1{,}44\ p.u.$$

$$tg(\varphi - \delta) = \frac{I_d}{I_q} = \frac{I_d}{I_q} \Rightarrow \varphi - \delta = 33{,}69^\circ$$

$$\varphi = 70{,}56^\circ$$

$$\frac{\partial P}{\partial \delta} = 2\cdot\frac{U^2}{2}\left(\frac{1}{X_q} - \frac{1}{X_d}\right)\cos(2\delta) = 0$$

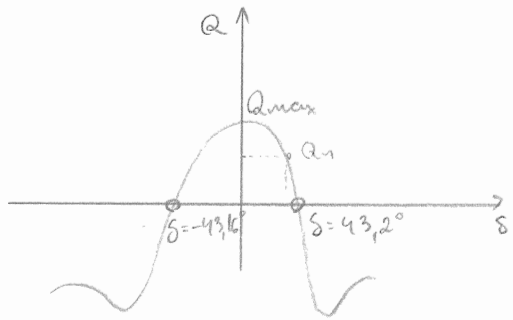
$$\delta_{pr} = 45^\circ, \quad P_{pr} = 1\ p.u.$$

X

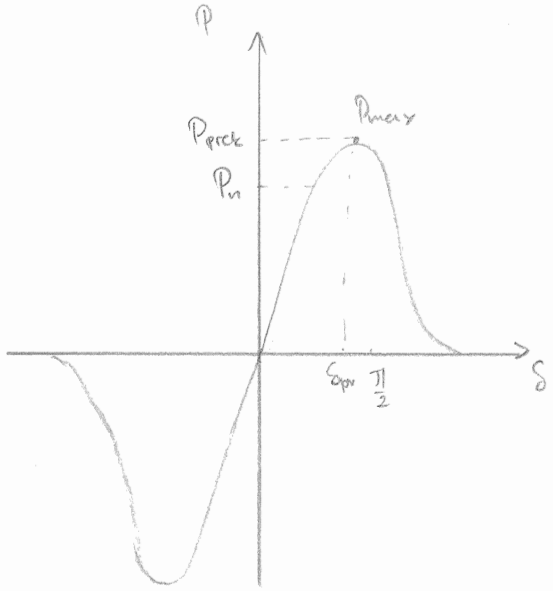
$P_{max} = 1,51\ p.u = 52,85\ MW$

$Q = 0$: $\cos \delta_1 = 43,2°$

$\cos \delta_2 = -6,9$



P



(4) Odredi induktivitete dinamičkog modela sinkr. stroja u p.u.

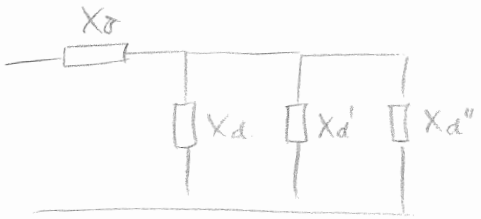
$X_d = 150\%$

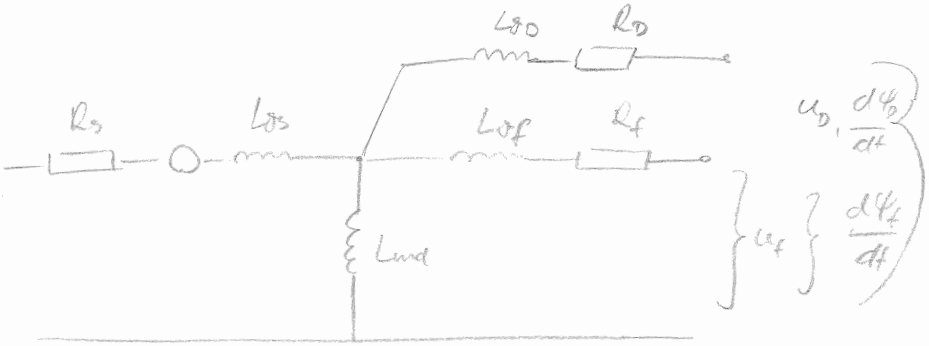
$X_q = 90\%$

$X_d' = 32\%$

$X_d'' = 21\%$

$X_\sigma = 12\%$

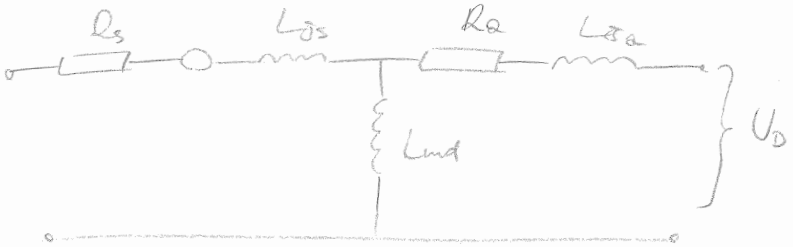




$L_{\sigma s} = 12\%$

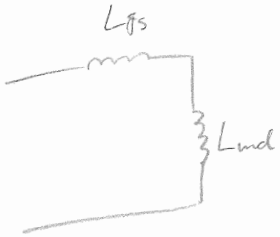
$L_{md} = ?$

$L_{\sigma 0}, L_{\sigma f}, L_{\sigma a} = ?$



D-os

stac. stanje

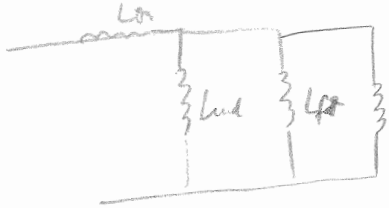


$\Rightarrow L_{md} = 158\%$

prijelazno

$\Rightarrow L_{\sigma f} = 23,39\%$

poč. stanje

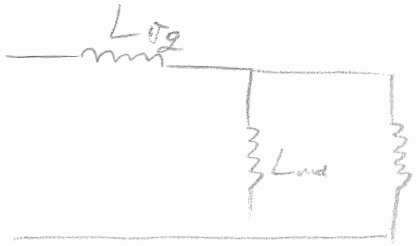


$\Rightarrow L_{\sigma\sigma} = 16,36.$

$L_f = L_{\sigma f} + L_{md}$

Q - os

poč. stanje



$L_{oq} \Rightarrow L_{oq} = 21,74\%$

14. 4. 2015

DIS

- auditorne 7

① Na PR-u napajanje preko 2 paral. jedn. trafoa

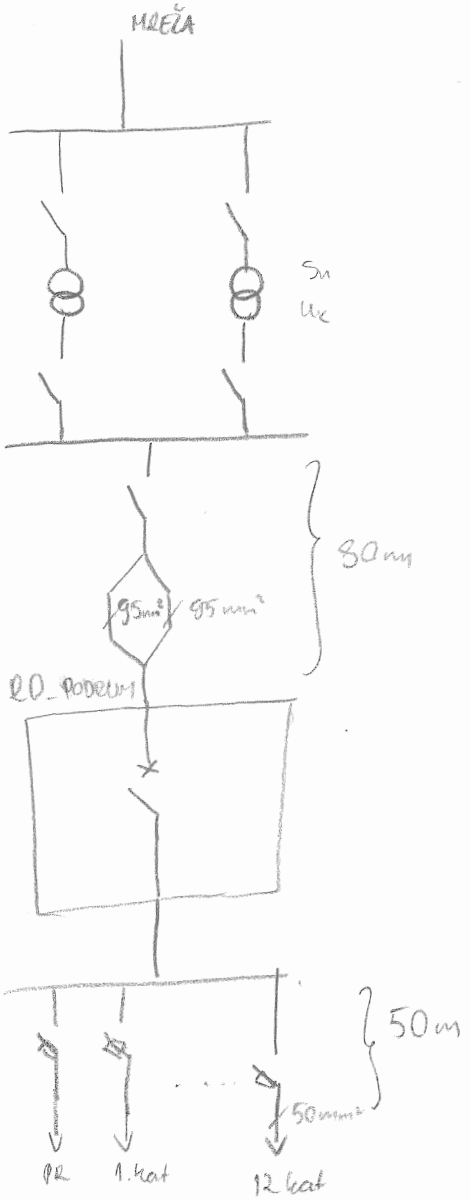
$S = 1\,MVA$

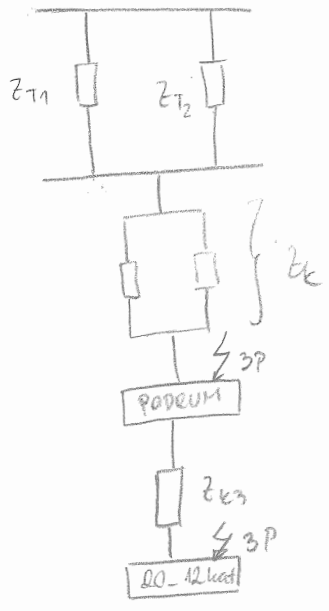
$U_n = 10/0{,}4\,kV$

$u_k = 5{,}8\,\%$

$\cos\varphi = 0{,}95$

- Izračunaj pot. prek. prac' prekidača u ormarima u podnum i na 12 katu C-ug.
- Kolika je $I_{k\,min}$ na najudaljenijoj utičnici?
- Odredi prekidač i presjek kabela za napajanje 1-f trošila snage $P = 3{,}5\,kW$ na 60 m udaljenosti.





$$X_T = \frac{u_k}{100} \cdot Z_B = \frac{u_k}{100} \cdot \frac{U_n^2}{100} \Rightarrow X_{T1}, X_{T2} = 9{,}28 \cdot 10^{-3}\,\Omega$$

$$X_T = \frac{1}{2} X_{T1} = 4{,}64 \cdot 10^{-3}\,\Omega$$

$\cos\varphi = 0{,}95 \Rightarrow \varphi = 18{,}19°$

$\frac{R}{X} = \operatorname{tg}\varphi \Rightarrow \frac{X}{R} = 3{,}042 \quad R_{T1}, R_{T2} = 3{,}05\,10^{-3}\,\Omega$

$$Z_{T1T2} = \sqrt{X_{T1T2}^2 + R_{T1T2}^2} = 9{,}77 \cdot 10^{-3}\,\Omega$$

$Z_T = 4{,}88 \cdot 10^{-3}\,\Omega$

XIV

$$z_{k1} = \sqrt{R^2 + X^2}$$

$S = 95\ mm^2$ — $R = 0{,}193\ \Omega/km$, $X = 0{,}082\ \Omega/km$

$$z_{k1} = \sqrt{\left(0{,}193 \cdot \frac{30}{1000}\right)^2 + \left(0{,}082 + \frac{80}{1000}\right)^2}$$

$$= 0{,}017\ \Omega$$

Druga formula za otpor bakrenog kabela

$$R_{Cu} = \frac{1}{56} \cdot \frac{\ell}{S} = 0{,}015\ \Omega$$

$$z_k = \frac{z_{k1}}{2} = 8{,}5 \cdot 10^{-3}\ \Omega$$

$$I_{k3} = \frac{c \cdot U}{\sqrt{3} \cdot z} = \frac{1{,}05 \cdot 400}{\sqrt{3} \cdot (4{,}85 + 8{,}5) \cdot 10^{-3}} = 18{,}123\ kA$$

$I_{cu} = 20\ kA$

---

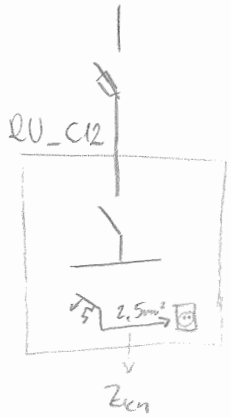
12 kat

$S = 50\ mm^2$ — $R = 0{,}387\ \Omega/km$, $X = 0{,}083\ \Omega/km$

$$z = 19{,}79 \cdot 10^{-3}\ \Omega$$

$$I_{k3} = \frac{420}{\sqrt{3}\,(4{,}85 + 8{,}5 + 9{,}79)\,10^{-3}} = 7{,}31\ kA$$

$I_{cu} = 10\ kA$



z_{k1}

$$z_k = \frac{z_{k12}}{2} = \frac{\sqrt{(2 \cdot 0{,}0154 + 0{,}0505)^2 + (2 \cdot 0{,}00656 + 0{,}0304)^2}}{2} = 46{,}27 \cdot 10^{-3}\ \Omega$$

$\gg 8{,}5\ m\Omega$

$z_{k3} = 103{,}76 \cdot 10^{-3}\ \Omega$

$z_{k1} = 1{,}407\ \Omega$

$\Big\}\ z_{uk} = 1{,}56\ \Omega$

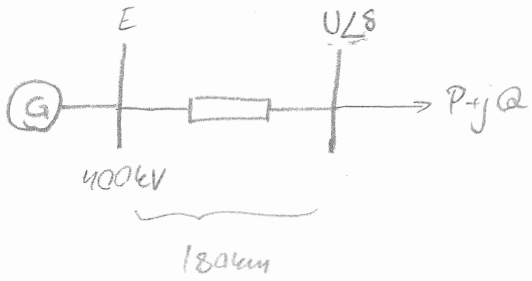
$$I_{k1min} \overset{c \to}{=} \frac{0.8 \cdot \sqrt{3} \cdot U}{1{,}56} = 355{,}3\ A$$

C16 $\quad I_{kmin} = 10 \cdot I_n = 160\ A$

XV

(2.) Iz TE Plomin prenosi se u ZG preko 220 kV dalekovoda $S = 300\,MVA$ uz $\cos f = 0,8$. Koliko % iznosi Δu na 180 km udaljenom mjestu u ZG, ako je $X = 0.25\,\Omega/km$. Koliku max S uz isti $\cos f$ možemo prenijeti tim vodom ako padnapona $\Delta u \leq 10\%$?

$X = 180 \cdot 0,25 = 45\,\Omega$



$$P = \frac{E \cdot U}{X} \sin\delta \qquad Q = \frac{E \cdot U}{Xd} \cos\delta - \frac{U^2}{X}$$

$$P^2 + \left(Q + \frac{U^2}{X}\right)^2 = \left(\frac{EU}{X}\right)^2 \sin^2\delta \quad ; \quad \sin^2\delta + \cos^2\delta = 1$$

$$P^2 + \left(Q + \frac{U^2}{X}\right)^2 = \left(\frac{EU}{X}\right)^2$$

$$\frac{1}{X^2} \cdot (U^2)^2 + \left(\frac{2Q}{X} - \frac{E^2}{X^2}\right) U^2 + \left(P^2 + Q^2\right) = 0$$

$$U_{1,2}^2 = \frac{E^2}{2} - Q \cdot X \pm X \sqrt{\frac{E^4}{4X^2} - P^2 - \frac{QE^2}{X}}$$

$U = 55,76\,kV \Rightarrow 8,94\%$

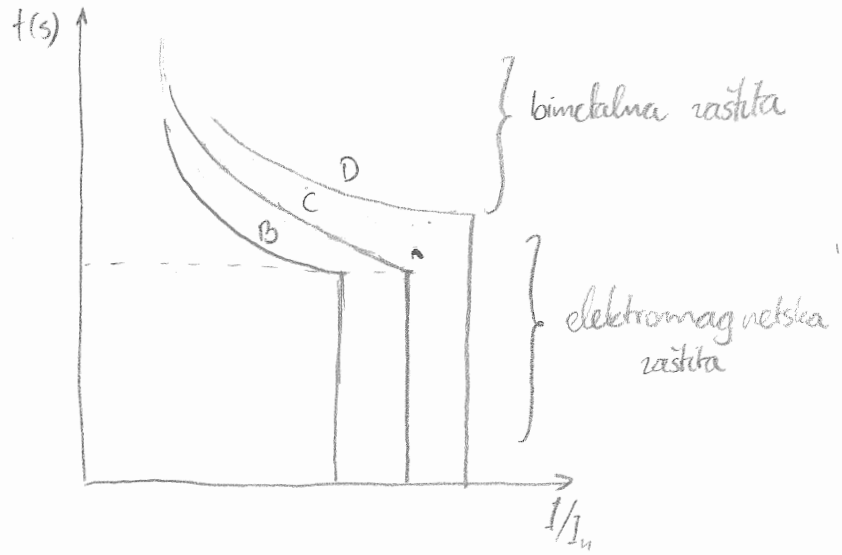
$\left.\begin{matrix} S > \\ X > \\ E < \end{matrix}\right\} \Delta U >$

$\Delta u = 10\%$

$U = 40\,kV$ $\qquad P = 0,8 \cdot S$, $Q = 0,65$

$$P^2 + \left(Q + \frac{U^2}{X}\right)^2 = \left(\frac{EU}{X}\right)^2 \rightarrow S = 330\,MVA \;\begin{matrix} \nearrow P = 264\,MW \\ \searrow Q = 198\,MVAr \end{matrix}$$

XVI



B $3 \div 5\ I_n$

C $7 \div 10\ I_n$

D $15 \div 20\ I_n$

$\Delta u\% < 5\%$

$P = U \cdot I \Rightarrow I = \frac{P}{U} = \frac{3500}{230} = 15,224\ ,\ 2,5\ mm^2$

$\Delta U = I \cdot R$

$R = \frac{1}{\gamma} \frac{l}{S} \Rightarrow R = \frac{1}{\gamma} \cdot \frac{2l}{S}$ za 1 fazni KS

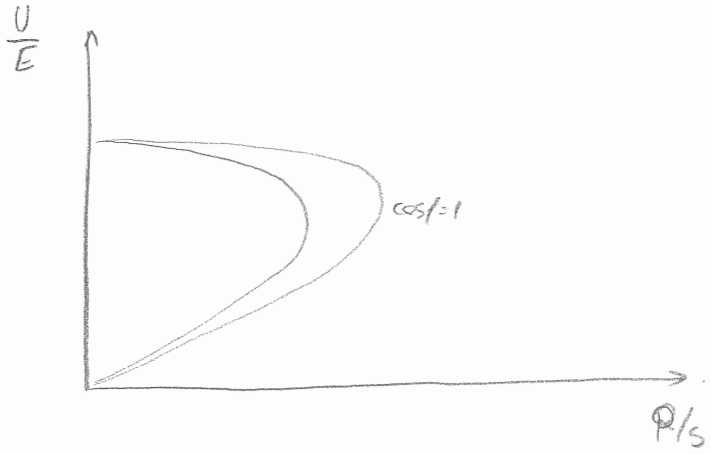
$u(\%) = \frac{\frac{1}{\gamma} \frac{2l}{S} \cdot I}{U} \cdot 100\% \quad I \to \frac{P}{U}$

$= \frac{1}{56} \cdot 100\% \cdot \frac{kW}{1000}$

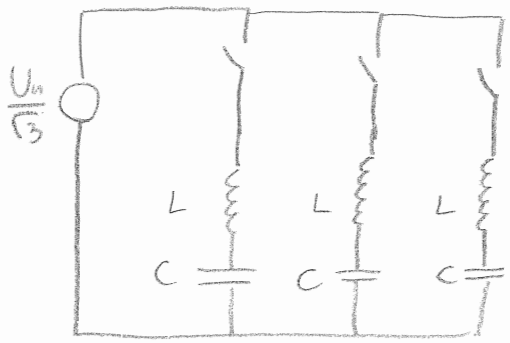
$P[kW] \Rightarrow k = 1793$

$u(\%) = \frac{2lPk}{U^2 S} < 5\% \ ; \ S > \frac{2 \cdot 60 \cdot 3,5}{230^2 \cdot 2,5} \cdot 1793 > 2,85\ mm^2$

$S = 4\ mm^2$



(3.) U paralelu 3 kaza kapaciteta svaki po Q=350 kVAr. Medusobno spojeni kabelima l=5 m, L=0,5 μH/m. U_f = 5,5 kV. Odredi omjer uklopne i nazivne struje grupe kapaciteta.



$$Q = C \cdot \omega \cdot U_n^2$$

$$C = \frac{Q}{\omega U_n^2} = \frac{350 \cdot 10^3}{(5{,}5 \cdot 10^3)^2 \cdot 3\pi} = 36{,}8\ \mu F$$

$$L = 5 \cdot 0{,}5 = 2{,}5\ \mu H$$

$$\omega_0 = \frac{1}{\sqrt{LC}} \Rightarrow f_0 = \frac{\omega_0}{2\pi} = 16{,}6\ kHz$$

vršni napon $\hat{U} = \sqrt{2}\ \frac{U_n}{\sqrt{3}}$ $\quad u(t) \begin{cases} 0, & t<0 \\ \hat{U}, & t \geq 0 \end{cases}$

$$u(t) = L\frac{di(t)}{dt} + \frac{1}{C}\int i(t)\,dt$$

$$i(t) = \frac{\hat{U}}{L\omega} \cdot \sin(\omega t)$$

$$i(t) = \boxed{\sqrt{\frac{2}{3}}\ U_n \cdot \sqrt{\frac{C}{L}}}\ \sin(\omega t)$$

$\hat{I}$ → vršna vrijednost struje

XVIII

$$L_{ers} = L \cdot \frac{n+1}{n}$$

$$C_{ers} = C \cdot \frac{n}{n+1}$$

$$\hat{I} = \sqrt{\frac{2}{3}}\, U_n \sqrt{\frac{C_{ers}}{L_{ers}}} = \sqrt{\frac{2}{3}} \cdot \frac{n}{n+1} \sqrt{\frac{C}{L}}\, U_n$$

$$I_{nC} = C \cdot \omega \cdot \frac{U_n}{\sqrt{3}}$$

$$\frac{\hat{I}}{I_n} = \frac{\sqrt{\frac{2}{3}} \frac{n}{n+1} U_n \sqrt{\frac{C}{L}}}{C \cdot \omega \cdot \frac{U_n}{\sqrt{3}}} = \sqrt{2} \frac{n}{n+1} \cdot \sqrt{\frac{LC}{\omega}} = \sqrt{2} \frac{n}{n+1} \frac{f_0}{f}$$

$$= \ldots = 313$$