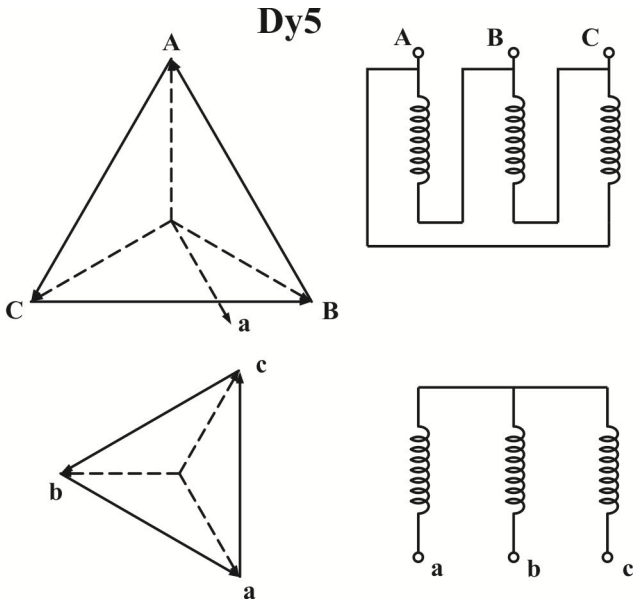
ЕНЕРГЕТСКИ ТРАНСФОРМАТОРИ (ОГЗЕТ)
- колоквијум-децембар 2014 -

Београд, 21.11.2014.

- РЕШЕЊА -

1. а)



б) $N_2 = N_1 \frac{U_{02}}{\sqrt{3}U_{1n}} = 2480 \frac{400}{\sqrt{3} \cdot 35 \cdot 10^3} \approx 17$

$$B_m = \frac{U_{1n}}{4,44 f N_1 k_{Fe} S_{Fe}} = \frac{35000}{4,44 \cdot 50 \cdot 2480 \cdot 0,95 \cdot 400 \cdot 10^{-4}} = 1,67\,T$$

2. а) теорија

б) $P_{vn} = \frac{P_{0n}}{3} = \frac{1420}{3} = 473,3\,W$

$P_v \sim U^2 \Rightarrow P_v^{'} = P_{vn}$

$P_h \sim \frac{U^n}{f^{n-1}} \Rightarrow P_h^{'} = P_{hn} \left(\frac{f_n}{f^{'}} \right)^{n-1} = 2 \cdot 473,3 \cdot \left(\frac{50}{60} \right) = 788,8W$

$P_{Fe}^{'} = P_h^{'} + P_v^{'} = 1262\,W$

3. $I_{2nf} = \frac{S_n}{\sqrt{3} \cdot U_{2n}} = \frac{630 \cdot 10^3}{\sqrt{3} \cdot 400} = 909,3\,A$

$R_a" = \frac{U_{0f}^2}{P_0/3} = \frac{U_0^2}{P_0} = \frac{400^2}{1420} = 112,7\,\Omega \qquad I_a" = \frac{U_{0f}}{R_a"} = \frac{400}{\sqrt{3} \cdot 112,7} = 2,05\,A$

$$I_\mu'' = \sqrt{{I_0}^2 - {I_a''}^2} = \sqrt{16,4^2 - 2,05^2} = 16,27\,A \Rightarrow X_\mu'' = \frac{U_{02}}{\sqrt{3}\cdot I_\mu''} = \frac{400}{\sqrt{3}\cdot 16,27} = 14,19\,\Omega$$

$$n = \frac{\sqrt{3}\cdot U_{1n}}{U_{02}} = \frac{\sqrt{3}\cdot 35}{0,4} = 151,6$$

$$R_k = \frac{P_k}{3\cdot I_{kf}^2} = \frac{P_k}{I_k^2} = \frac{6500}{9^2} = 80,25\,\Omega \Rightarrow R_k'' = \frac{R_k}{n^2} = \frac{80,25}{151,6^2} = 3,5\,m\Omega$$

$$R_1'' \approx R_2 = \frac{R_k}{2} = 1,75\,m\Omega$$

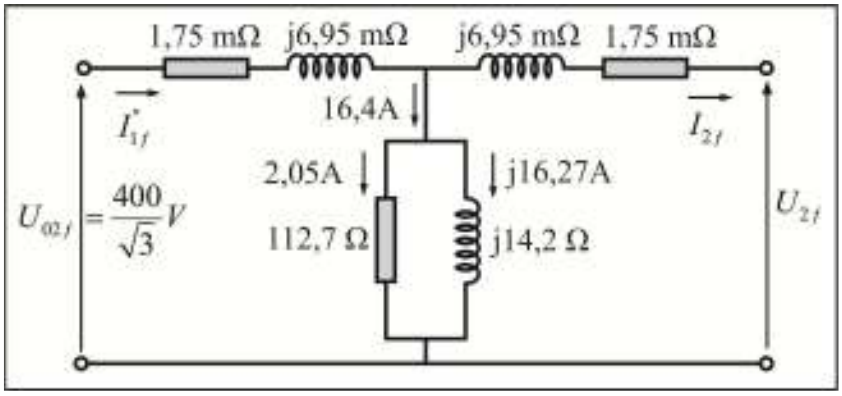
$$Z_k'' = \frac{Z_k}{n^2} = \frac{U_{kf}}{I_{kf} n^2} = \frac{\sqrt{3}\cdot 1715}{9\cdot 151,6^2} \approx 14,4\,m\Omega$$

$$X_k'' = \sqrt{{Z_k''}^2 - {R_k''}^2} = \sqrt{14,4^2 - 3,5^2} = 13,97\,m\Omega \Rightarrow X_{\sigma 1}'' \approx X_{\sigma 2} = \frac{X_k}{2} = 6,98\,m\Omega$$

$$u_k = \frac{U_{kf}}{U_{1nf}}\cdot 100 = \frac{1715}{35000}\cdot 100 = 4,9\,\%$$

$$u_{kn} = u_{k\%}\cdot\left(\frac{I_{1n}}{I_k}\right) = 4,9\cdot\left(\frac{6\sqrt{3}}{9}\right) = 5,66\,\%$$

$$P_{kn}^{75} = P_k\left(\frac{I_{1n}}{I_k}\right)^2 = 6500\cdot\left(\frac{6\sqrt{3}}{9}\right)^2 = 8667\,W$$



4. $k_F = 1 + \left(\frac{\pi\mu_0 f}{\rho}\right)^2 \frac{m^2 d^4}{19,4}$; $\qquad \rho_{Cu}^{75^\circ} = \frac{235+75}{235+20}\cdot\frac{10^{-6}}{57} = \frac{10^{-6}}{46,9}\,\Omega m$

$$k_F^{75^\circ} = 1 + \left(\frac{4\cdot\pi^2\cdot 50\cdot 10^{-7}}{10^{-6}/46,9}\right)^2 \cdot \frac{100\cdot 1,6^4\cdot 10^{-12}}{19,4} = 1 + 0,0029 = 1,0029$$

$$P_d^{75^\circ} = \left(1 - \frac{1}{k_F}\right)\cdot P_k^{75^\circ} = 25,1\,W$$

5. a) $\beta_m = \sqrt{\frac{P_{0n}}{P_{kn}}} = \sqrt{\frac{1420}{8667}} = 0,4\,,\ \cos\varphi = 1$

$$u_{rn} = \frac{P_{kn}}{S_n}\cdot 100 = \frac{8667}{630\cdot 10^3}\cdot 100 = 1,38\,\% \Rightarrow u_x = \sqrt{u_k^2 - u_r^2} = \sqrt{5,66^2 - 1,38^2} = 5,49\,\%$$

$$\left.\begin{aligned} a &= \beta_m u_{rn} = 0,55\,\% \\ b &= \beta_m u_{xn} = 2,22\,\% \end{aligned}\right\} \Rightarrow \Delta u = a + \frac{b^2}{200} = 0,584\,\%$$

$$U_2 = U_{02}\left(1 - \frac{\Delta u}{100}\right) = 400\cdot\left(1 - \frac{0,584}{100}\right) = 397,7\,V$$

$$\eta_{m\%} = \frac{\beta_m \cdot S_n}{\beta_m \cdot S_n + 2P_{0n}}\cdot 100 = \frac{0,4\cdot 630}{0,4\cdot 630 + 2\cdot 1,42} = 98,89\,\%$$

6. $\theta_{m1} = \frac{P_{0n} + \beta_1^{\,2} P_{kn}}{P_{0n} + P_{kn}}\cdot\theta_{mn} = \frac{1,42 + 0,8^2\cdot 8,67}{1,42 + 8,67}\cdot 55 = 38\,K$

$$\beta_2 = 0,8 + 0,5 = 1,3 \Rightarrow \theta_{m2} = \frac{P_{0n} + \beta_2^{\,2} P_{kn}}{P_{0n} + P_{kn}}\cdot\theta_{mn} = \frac{1,42 + 1,3^2\cdot 8,67}{1,42 + 8,67}\cdot 55 = 87,6\,K$$

$$\theta_2 = \theta_{mn} = \theta_{m2}\left(1 - e^{-t_x/2}\right) + \theta_{m1}e^{-t_x/2} \Rightarrow t_x = 2\cdot\ln\frac{\left(\theta_{m2} - \theta_{m1}\right)}{\left(\theta_{m2} - \theta_{mn}\right)} = 2\cdot\ln\frac{\left(87,6 - 38\right)}{\left(87,6 - 55\right)} \approx 50\,\text{min}$$

7. теоријско питање

8. теоријско питање