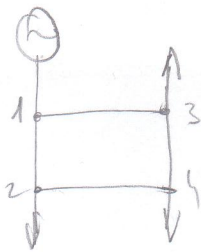


~ABS

ЗАУДАТ

2008-2009

①



$$S_b = 100 \text{ MVA}$$

$$U_n = 110 \text{ kV}$$

1. Сформулируйте задачу

$$S_2 = -50 + j10 \text{ MVA} \Rightarrow -0.5 + j0.1 [\text{p.u.}]$$

$$S_3 = 0 + j0 \text{ MVA}$$

$$S_4 = -50 + j10 \text{ MVA} \Rightarrow -0.5 + j0.1 [\text{p.u.}]$$

$$K_{Li} = \frac{\vec{S}_i^*}{\vec{Y}_{ii}}$$

$$Y_{Lij} = \frac{\vec{Y}_{ij}}{\vec{Y}_{ii}}$$



$$\text{так как } (n-1) = 3 \Rightarrow K_{L2}, K_{L3}, K_{L4}$$

$$K = \begin{bmatrix} K_{L1} & Y_{L12} & Y_{L13} & Y_{L14} \\ Y_{L21} & K_{L2} & Y_{L23} & Y_{L24} \\ Y_{L31} & Y_{L32} & K_{L3} & Y_{L34} \\ Y_{L41} & Y_{L42} & Y_{L43} & K_{L4} \end{bmatrix}$$

$$Z [\text{p.u.}] = Z \cdot \frac{S_b}{U_n^2}$$

$$Y [\text{p.u.}] = Y \cdot \frac{U_n^2}{S_b}$$

$$Z_{12} = (0.1 \text{ } \Omega/\text{km} + j0.4 \text{ } \Omega/\text{km}) \cdot 50 \text{ km} = 5 + j20 [\Omega] = 0.04132 + j0.16528 [\text{p.u.}]$$

$$Z_{13} = (0.14 \text{ } \Omega/\text{km} + j0.42 \text{ } \Omega/\text{km}) \cdot 20 \text{ km} = 11.2 + j33.6 [\Omega] = 0.05256 + j0.27768 [\text{p.u.}]$$

$$Z_{24} = (0.05 \text{ } \Omega/\text{km} + j0.32 \text{ } \Omega/\text{km}) \cdot 10 \text{ km} = 7.5 + j48 [\Omega] = 0.061483 + j0.38664 [\text{p.u.}]$$

$$Z_{34} = (0.2 \text{ } \Omega/\text{km} + j0.42 \text{ } \Omega/\text{km}) \cdot 20 \text{ km} = 4 + j8.4 [\Omega] = 0.033557 + j0.069421 [\text{p.u.}]$$

$$Z_{12} = 0.04132 + j0.16528 [\text{p.u.}]$$

$$Z_{13} = 0.05256 + j0.27768 [\text{p.u.}]$$

$$Z_{24} = 0.061483 + j0.38664 [\text{p.u.}]$$

$$Z_{34} = 0.033557 + j0.069421 [\text{p.u.}]$$



$$Y_{12} = 1.42352 - j5.694117$$

$$Y_{13} = 1.080357 - j3.241071$$

$$Y_{24} = 0.384493 - j2.46075$$

$$Y_{34} = 5.531487 - j11.742144$$

p.u.

7253A part  $Y_{22}, Y_{33}, Y_{44}$

$$Y_{22} = 1.8080 - j8.15486$$

$$Y_{33} = 6.67185 - j14.98321$$

$$Y_{44} = 5.97589 - j14.20283$$

$$K_{L2} = \frac{(-0.5 - j0.1)}{1.8080 - j8.15486} = -0.001268 - j0.061031 \text{ [p.u.]}$$

$$K_{L3} = \frac{0}{6.67185 - j14.98321} = \phi \text{ [p.u.]}$$

$$K_{L4} = \frac{-0.5 - j0.1}{5.97589 - j14.20283} = -0.006602 - j0.032459 \text{ [p.u.]}$$

$$Y_{L23} = \frac{Y_{23}}{Y_{22}} = \frac{\phi}{1.8080 - j8.15486} = \phi$$

$$Y_{L24} = \frac{Y_{24}}{Y_{22}} = \frac{0.384493 - j2.46075}{1.8080 - j8.15486} = \underline{0.21757 - j0.0282}$$

$$Y_{L32} = \frac{Y_{32}}{Y_{33}} = \frac{0}{6.67185 - j14.98321} = \phi$$

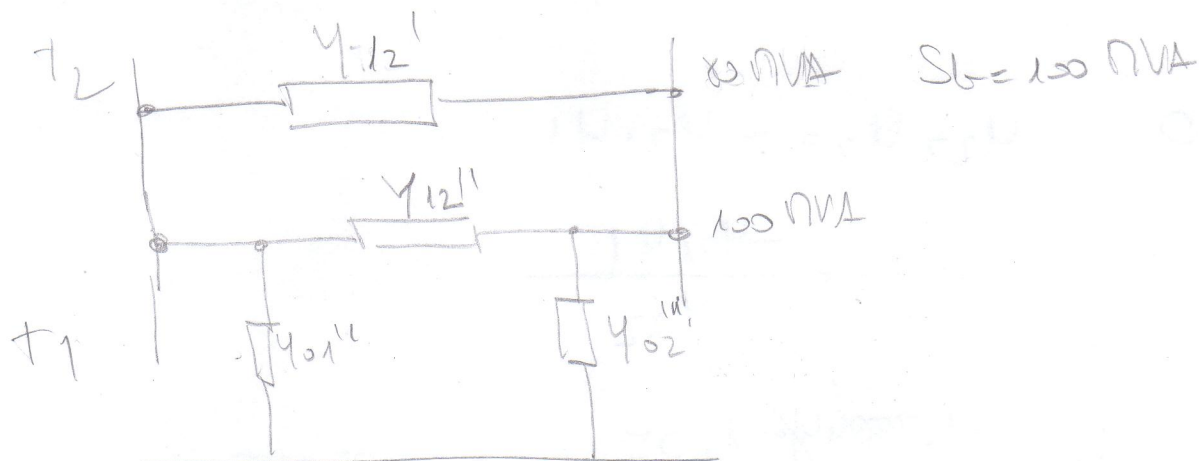
$$Y_{L34} = \frac{Y_{34}}{Y_{33}} = \frac{5.531487 - j11.742144}{6.67185 - j14.98321} = \underline{0.79268 + j0.02021}$$

$$Y_{L42} = \frac{Y_{42}}{Y_{44}} = \underline{0.15687 - j0.03893} \quad Y_{L43} = \frac{Y_{43}}{Y_{44}} = \underline{0.8431 + j0.03893}$$

(2)

$$U_1 = 231 \text{ kV} = 1.05 [\text{p.u.}]$$

	$S_m$	$u_k$	$u$
$T_1$	100 MVA	12%	220/115
$T_2$	80 MVA	11.5%	220/110



$$\alpha_1 = \frac{\frac{220}{115}}{\frac{220}{110}} = 0.95621$$

$$Z_T = j \frac{u_m^2}{S_m} \cdot u_k = j X_T \quad Y_T = -j \frac{1}{X_T} = -j B_T$$

$$Y_{T2} = -j \frac{1}{\frac{u_m^2}{S_m} \cdot u_k} = -j \frac{S_m}{u_m^2 \cdot u_k} \cdot \frac{u_m^2}{S_b} \rightarrow \text{2A p.u.} \quad \leftarrow S_m = S_b$$

$$Y_{T2}'' = -\frac{1}{u_k^2} = -j 8.333 [\text{p.u.}]$$

$$Y_{12}'' = \frac{Y_{T2}}{\alpha} = \frac{-j 8.333}{0.95621} = -j 8.71496$$

$$Y_{01}'' = \frac{Y_{T1}}{\alpha_1} \left( \frac{1}{u_k} - 1 \right) = -j 8.71496 \left( \frac{1}{0.95621} - 1 \right) = -j 0.3991$$

$$Y_{02}'' = -j 8.333 \left( 1 - \frac{1}{0.95621} \right) = -j 0.38161$$

$$Y_{12}' = \frac{S_m}{S_b \cdot \text{p.u.}} = -j \frac{80}{100 \cdot 11.5} = -j 6.95652 \text{ p.u.}$$

$$Y = \begin{bmatrix} Y_{12}' + Y_{12}'' + Y_{01}'' & -(Y_{12}' + Y_{12}'') \\ -(Y_{12}' + Y_{12}'') & Y_{12}' + Y_{12}'' + Y_{02}'' \end{bmatrix} = \begin{bmatrix} -2.19759j & 1.75844j \\ 1.75844j & -2.14j \end{bmatrix}$$

$$\begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = [Y] \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

$$v_1 = Y_{11} u_1 + Y_{12} u_2$$

$$v_2 = Y_{21} u_1 + Y_{22} u_2$$

$$v_2 = 0 \quad Y_{22} u_2 = -Y_{21} u_1$$

$$u_2 = \frac{-Y_{21} u_1}{Y_{22}}$$

$$u_2 = \frac{-1.75844 \cdot 1.05}{-2.14} = 0.862785 \text{ p.u.}$$

2mo di 115 4.22

$u_2 = 84.9263 \text{ kV}$

3

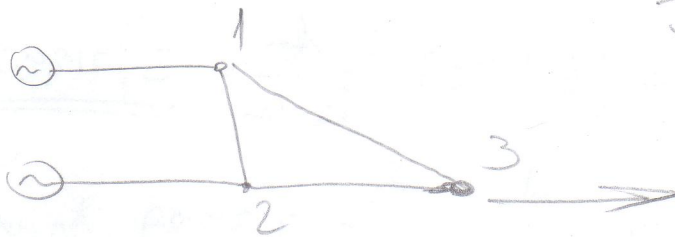
3KS

$$X_{1-2} = j0.4 \cdot 60 = j24 \Omega \cdot \frac{S_b}{u_{n2}} = j0.148347 \text{ p.u.}$$

$$X_{1-3} = j0.42 \cdot 120 = j50.4 \Omega = j0.416528 \text{ p.u.}$$

$$X_{2-3} = j0.32 \cdot 50 = j16 \Omega = j0.13223 \text{ p.u.}$$

$$S_b = 100 \text{ MVA} \quad u_n = 110 \text{ kV}$$



$$Z_k [Z] = Z$$

Go	$X_{ij}'' [\Omega]$	$S_{in} [\text{MVA}]$
1	10	100
2	12	100

$$\rightarrow X_{d2}'' = \left( \frac{1}{j0.1} \right) = -j10$$

$$\rightarrow X_{d2}'' = \left( \frac{1}{j0.12} \right) = -j8.333$$

$$Y_{12} = j5.211669 \text{ p.u.}$$

$$Y_{1-3} = j2.4 \text{ p.u.}$$

$$Y_{2-3} = -j7.56258 \text{ p.u.}$$

$$Y = \begin{bmatrix} -17.441j & 5.211669j & 2.4j \\ 5.211669j & -29.9372j & 7.56258j \\ 2.4j & 7.56258j & -9.96258j \end{bmatrix}$$

$$Z_d = Z = Y^{-1}$$

$$Z_0 = Z = \begin{bmatrix} 0.107265i & 0.032216i & 0.14146i \\ 0.032216i & 0.086264i & 0.064188i \\ 0.14146i & 0.064188i & 0.163553i \end{bmatrix}$$

$$\begin{bmatrix} u_1^Z \\ u_2^Z \\ u_3^Z \end{bmatrix} = \begin{bmatrix} u_1^Z \\ u_2^Z \\ u_3^Z \end{bmatrix} + 1741 \begin{bmatrix} 0 \\ 0 \\ 453 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} + 1741 \begin{bmatrix} 0 \\ 0 \\ 453 \end{bmatrix}$$



$$\begin{bmatrix} du_1^k \\ du_2^k \\ du_3^k \end{bmatrix} = \begin{bmatrix} 1 + z_{13} \cdot J_3 \\ 1 + z_{23} \cdot J_3 \\ 1 + z_{33} \cdot J_3 \end{bmatrix}$$

$$du_3^k = 0 = 1 + z_{33} \cdot J_3$$

$$J_3 = - \frac{1}{z_{33}} = J \frac{1}{0.163053} = J 6.13297 \text{ p.u.}$$

$$J_B[A] = J 6.13297 \cdot \frac{S_b}{T_{b,un}} = \underline{\underline{3.2897 \text{ kA}}}$$

$$du_1^k = 1 + z_{13} \cdot J_3 = 0.73987 \text{ p.u.}$$

$$du_2^k = 1 + z_{23} \cdot J_3 = 0.576177 \text{ p.u.}$$

$$du_3^k = 0$$

$$J_{1-2} = \frac{du_1^k - du_2^k}{X_{1-2}} = \frac{0.73987 - 0.576177}{j 0.148347} = -j \underline{\underline{0.82508}}$$

$$J_{2-3} = \frac{du_2^k - du_3^k}{X_{2-3}} = \frac{0.576177 - 0}{j 0.13223} = -j \underline{\underline{4.35723}}$$

$$J_{1-3} = \frac{du_1^k - du_3^k}{X_{1-3}} = \frac{0.73987 - 0}{j 0.116528} = -j \underline{\underline{1.77677}}$$