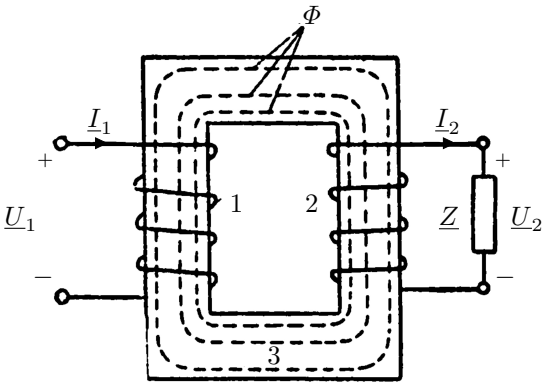
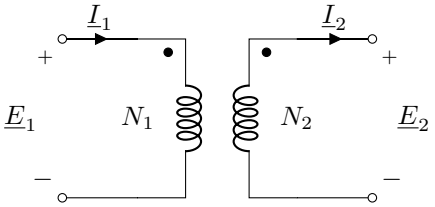
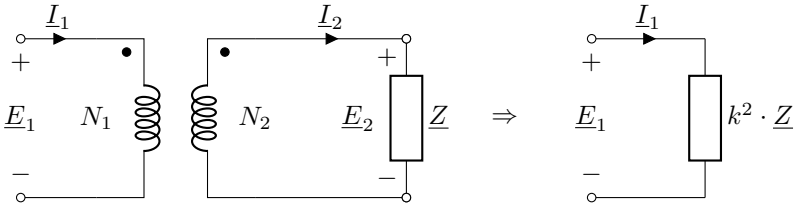
1 Идеален трансформатор



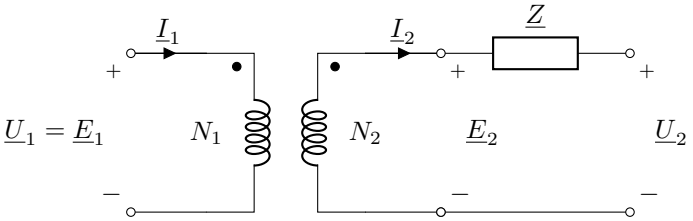


$$k = \frac{N_1}{N_2} \quad \frac{\underline{E}_1}{\underline{E}_2} = k \quad \frac{\underline{I}_2}{\underline{I}_1} = k$$

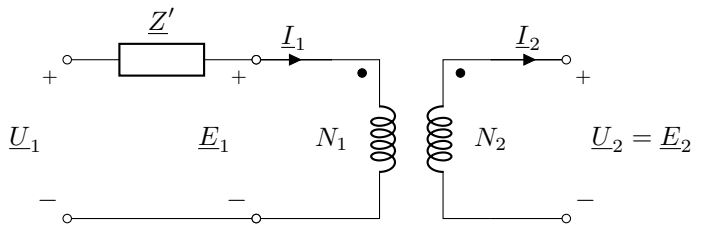


$$\underline{E}_2 = \underline{Z} \cdot \underline{I}_2$$
$$\underline{E}_1 = k \cdot \underline{E}_2 = k \cdot \underline{Z} \cdot \underline{I}_2 = k \cdot \underline{Z} \cdot k \cdot \underline{I}_1 = k^2 \cdot \underline{Z} \cdot \underline{I}_1$$
$$\frac{\underline{E}_1}{\underline{I}_1} = k^2 \cdot \underline{Z}$$

2 Сведување на импеданции



$$\underline{U}_2 = \underline{E}_2 - \underline{Z} \cdot \underline{I}_2$$
$$\underline{U}_2 = \frac{\underline{E}_1}{k} - k \cdot \underline{Z} \cdot \underline{I}_1 = \frac{\underline{U}_1}{k} - k \cdot \underline{Z} \cdot \underline{I}_1$$



$$\underline{U}_1 = \underline{E}_1 + \underline{Z}' \cdot \underline{I}_1 \quad \Rightarrow \quad \underline{E}_1 = \underline{U}_1 - \underline{Z}' \cdot \underline{I}_1$$
$$\underline{U}_2 = \underline{E}_2 = \frac{\underline{E}_1}{k} = \frac{\underline{U}_1}{k} - \frac{\underline{Z}'}{k} \cdot \underline{I}_1$$

Со споредба на равенките

$$\underline{U}_2 = \frac{\underline{U}_1}{k} - k \cdot \underline{Z} \cdot \underline{I}_1$$

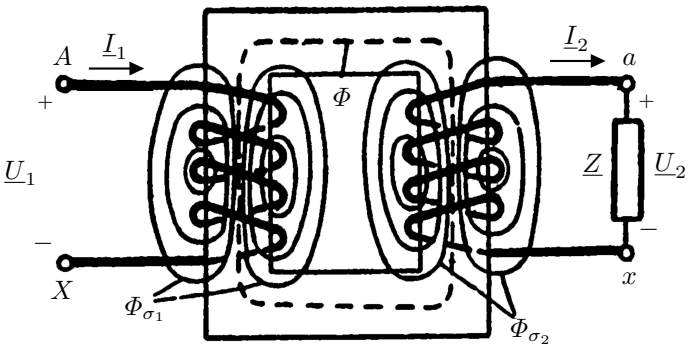
и

$$\underline{U}_2 = \frac{\underline{U}_1}{k} - \frac{\underline{Z}'}{k} \cdot \underline{I}_1$$

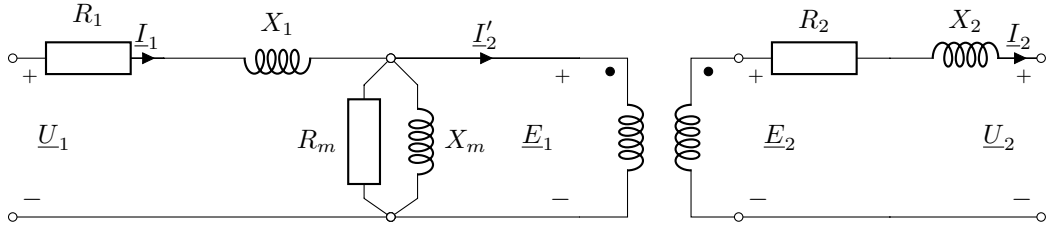
добиваме

$$k \cdot \underline{Z} = \frac{\underline{Z}'}{k} \quad \Rightarrow \quad \underline{Z}' = k^2 \cdot \underline{Z}$$

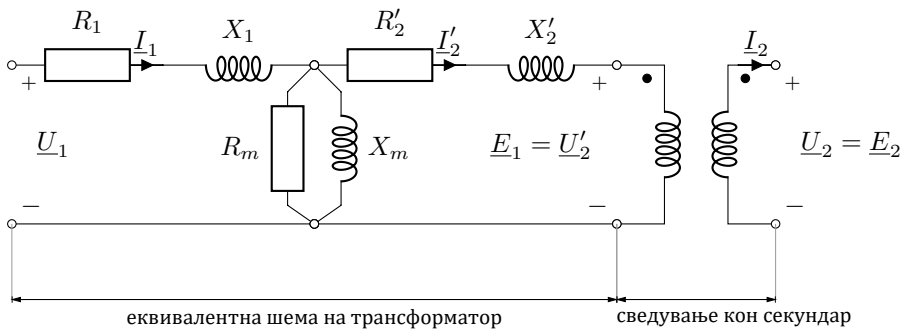
3 Реален трансформатор



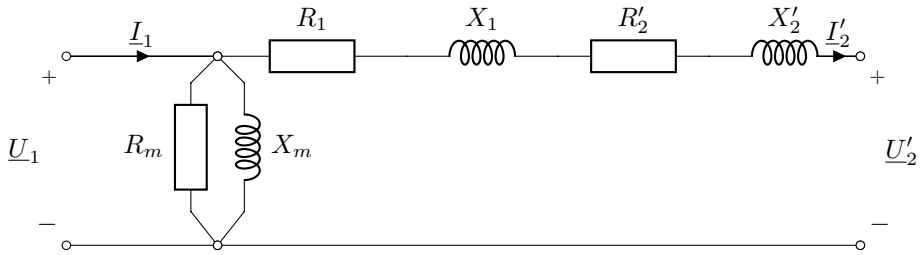
$$\Phi \quad \rightarrow \quad L_m \quad \rightarrow \quad X_m = \omega \cdot L_m$$
$$\Phi_{\sigma_1} \quad \rightarrow \quad L_1 \quad \rightarrow \quad X_1 = \omega \cdot L_1$$
$$\Phi_{\sigma_2} \quad \rightarrow \quad L_2 \quad \rightarrow \quad X_2 = \omega \cdot L_2$$
$$R_1, R_2 \quad \rightarrow \quad \text{активен отпор на намотките}$$
$$R_m \quad \rightarrow \quad \text{загуби на моќност во јадрото}$$

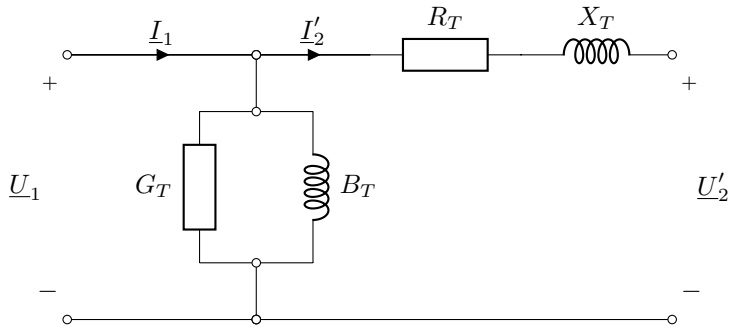


R_2 и X_2 ги префрламе на примарната страна, при што нивните вредности се $R_2' = k^2 \cdot R_2$ и $X_2' = k^2 \cdot X_2$.



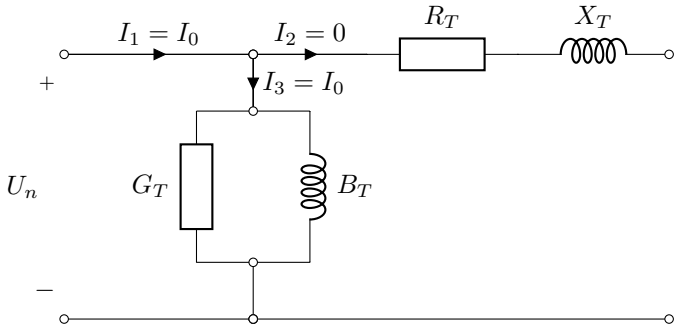
Ако елементите R_m и X_m ги префрлиме од средината на еквивалентата шема на нејзиниот почеток ќе направиме занемарлива грешка затоа што е $R_m \gg R_1 + R_2'$ и $X_m \gg X_1 + X_2'$.





$$R_T = R_1 + R_2' \quad G_T = 1/R_m$$
$$X_T = X_1 + X_2' \quad B_T = 1/X_m$$

4 Обид на празен од



Измерени величини: I_0 и P_0. Струјата I_0 се изразува во проценти од номиналната

струја $I_0 = i_0/100 \cdot I_n$.

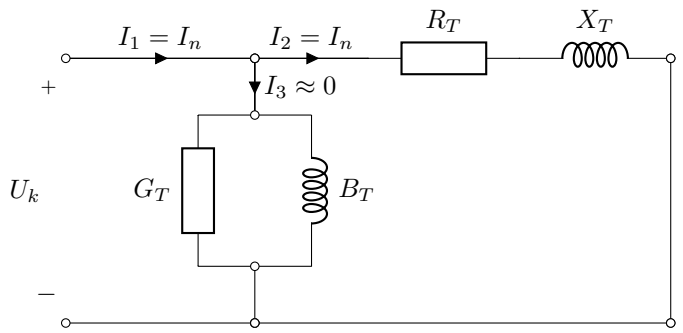
$$P_0 = 3 \cdot G_T \cdot \left(\frac{U_n}{\sqrt{3}}\right)^2 = G_T \cdot U_n^2$$

$$\boxed{G_T = \frac{P_0}{U_n^2}}$$

$$Y_T = \frac{I_0}{U_n/\sqrt{3}} = \frac{\frac{i_0}{100} \cdot I_n \cdot \sqrt{3}}{U_n} \cdot \frac{U_n}{U_n} \quad \Rightarrow \quad \boxed{Y_T = \frac{i_0}{100} \cdot \frac{S_n}{U_n^2}}$$

$$\boxed{B_T = -\sqrt{Y_T^2 - G_T^2}}$$

5 Обид на куса врска



$$U_k \ll U_n, \quad I_3 \ll I_0 \lll I_n, \quad \Rightarrow I_3 \approx 0$$

Измерени величини: U_k и P_k. Напонот U_k се изразува во проценти од номиналниот напон $U_k = u_k/100 \cdot U_n$.

$$P_k = 3 \cdot R_T \cdot I_n^2 = 3 \cdot R_T \left(\frac{S_n}{\sqrt{3} \cdot U_n}\right)^2 = R_T \cdot \frac{S_n^2}{U_n^2}$$

$$\boxed{R_T = P_k \cdot \frac{U_n^2}{S_n^2}}$$

$$Z_T = \frac{U_k/\sqrt{3}}{I_n} = \frac{\frac{u_k}{100} \cdot U_n/\sqrt{3}}{\frac{S_n}{\sqrt{3} \cdot U_n}} \quad \Rightarrow \quad \boxed{Z_T = \frac{u_k}{100} \cdot \frac{U_n^2}{S_n}}$$

$$\boxed{X_T = \sqrt{Z_T^2 - R_T^2}}$$