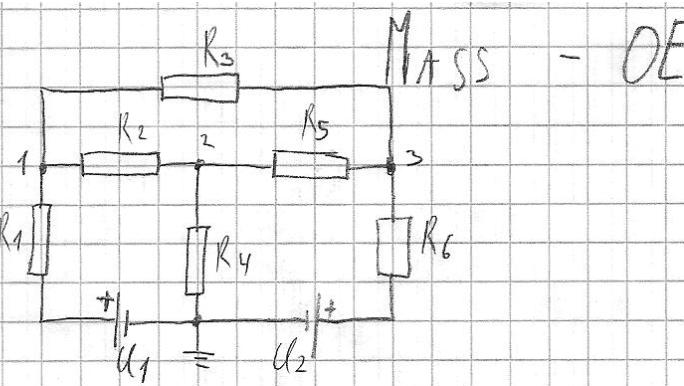


3.CIKLUS

1. MASOVNE IZ OSNOVA ELEKTROTEHNIKE

BY TYWIN & HMP

20.12.2009



$$Y_1 \left( \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right) - Y_2 \left( \frac{1}{R_2} \right) - Y_3 \left( \frac{1}{R_3} \right) = \frac{U_1}{R_1}$$

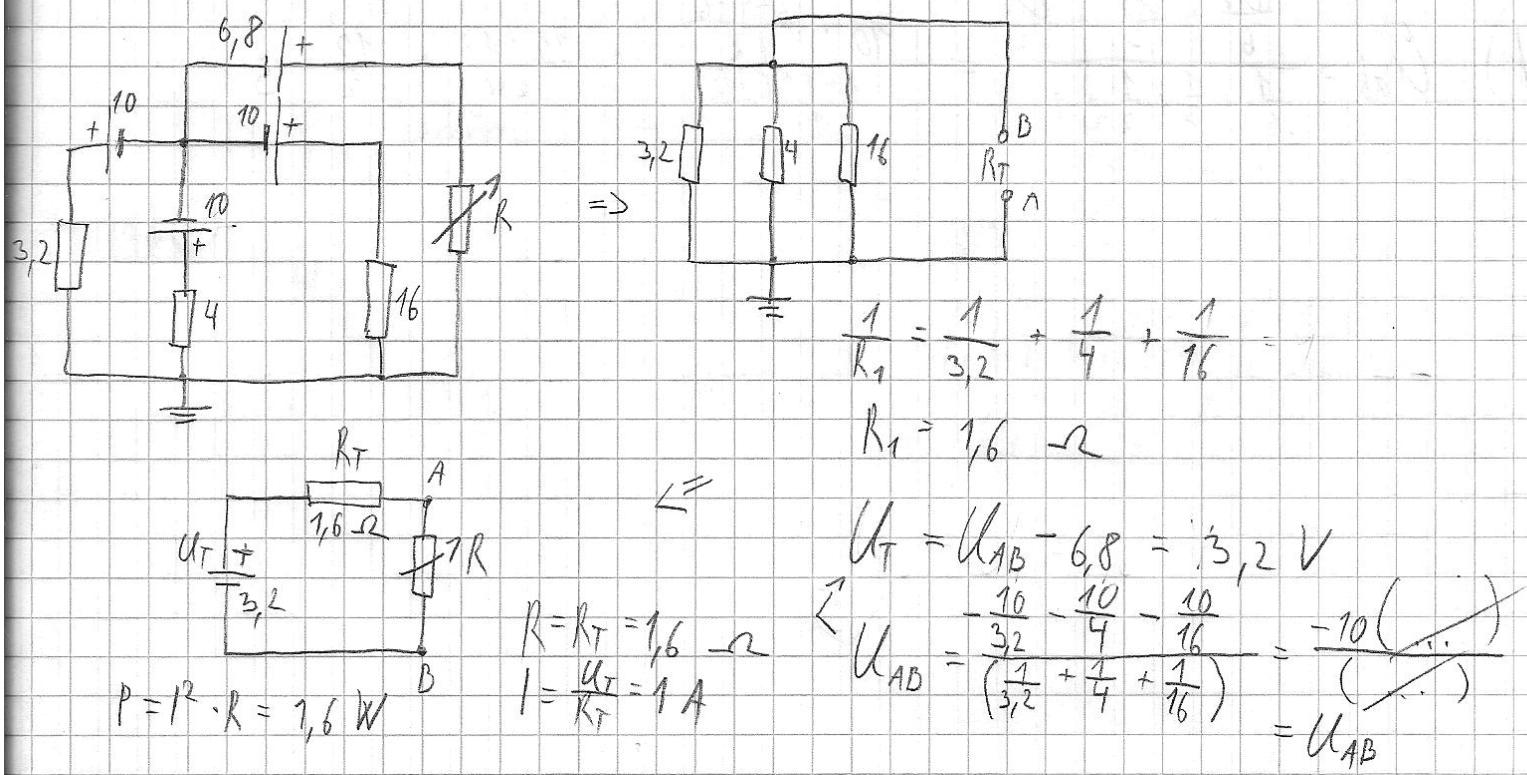
$$Y_2 \left( \frac{1}{R_2} + \frac{1}{R_4} + \frac{1}{R_5} \right) - Y_1 \left( \frac{1}{R_2} \right) - Y_3 \left( \frac{1}{R_5} \right) = 0$$

$$Y_3 \left( \frac{1}{R_3} + \frac{1}{R_5} + \frac{1}{R_6} \right) - Y_2 \left( \frac{1}{R_5} \right) - Y_1 \left( \frac{1}{R_3} \right) = \frac{U_2}{R_6}$$

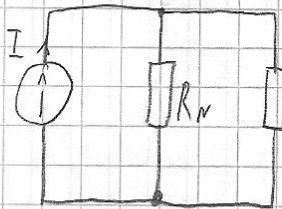
- naponski izvor ima otpor nula, vodljivost beskonačna
- strujni izvor ima beskonacan otpor, vodljivost nula

## ② THEVENEN

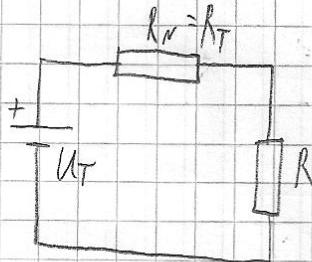
- ugasiti izvore i izbaciti traženi otpor
- izračunati Theveninov otpor
- vratiti izvore i računati  $U_{AB}$



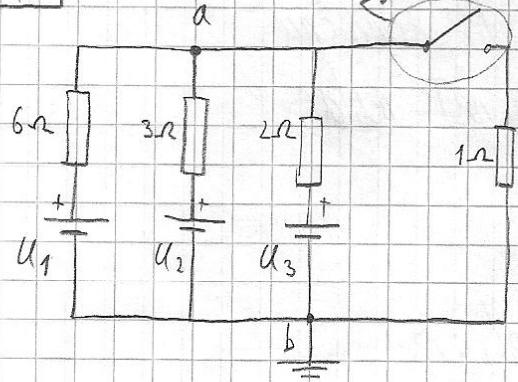
### 3) NORTONOV TEOREM



$$R_N = R_T$$



X. 1-13



$$U_1 = U_2 = U_3 = 10 \text{ V}$$

$$V_a = ?$$

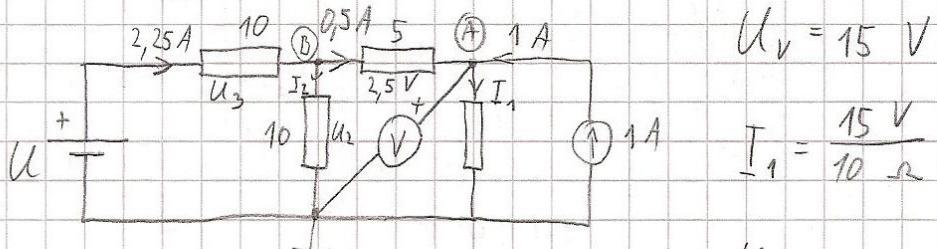
$$U_{ab} = \frac{\frac{U_1}{6} + \frac{U_2}{3} + \frac{U_3}{2}}{\left(\frac{1}{6} + \frac{1}{3} + \frac{1}{2}\right)} = \frac{10}{\left(\frac{1}{6} + \frac{1}{3} + \frac{1}{2}\right)} = 10 \text{ V}$$

$$U_{ab} = V_a - V_b \xrightarrow{V_b=0 \text{ V}} V_a$$

$$V_a = 10 \text{ V}$$

$$\text{b) } U_{ab} = \frac{\frac{U_1}{6} + \frac{U_2}{3} + \frac{U_3}{2}}{\frac{1}{6} + \frac{1}{3} + \frac{1}{2} + 1} = \frac{10 \cdot \frac{2+4+6}{12}}{\frac{2+4+6+12}{12}} = \frac{10 \cdot 12}{34} = \frac{10}{2} = 5 \text{ V}$$

X. 1-7



$$I_1 = \frac{15 \text{ V}}{10 \Omega} = \frac{3}{2} \text{ A}$$

$$U_3 = 22,5 \text{ V}$$

$$U_1 = 0,5 \cdot 5 = 2,5 \text{ V}$$

$$U_2 = 17,5 \text{ V} \quad (\Rightarrow 15 + 2,5)$$

$$U = U_2 + U_3 = 40 \text{ V}$$

$$I_2 = \frac{17,5}{10} = 1,75 \text{ A}$$

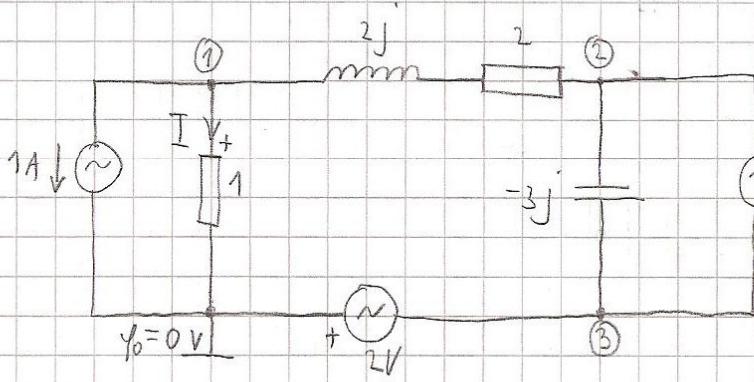
-2. NACIN

$$\begin{aligned} Y_A &= 15 \text{ V} \\ Y_A \left( \frac{1}{10} + \frac{1}{5} \right) - Y_B \left( \frac{1}{5} \right) &= 1 \end{aligned}$$

$$Y_B = 17,5 \text{ V}$$

$$Y_B \left( \frac{1}{5} + \frac{1}{10} + \frac{1}{10} \right) - Y_A \left( \frac{1}{5} \right) = +\frac{U}{10}$$

$$U = 40 \text{ V}$$

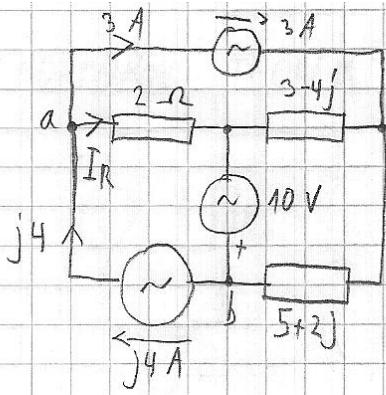


$$Y_3 = -2 \text{ V}$$

$$Y_2 = -2 + 2j$$

$$Y_1 \left( \frac{1}{1} + \frac{1}{2+2j} \right) - Y_2 \left( \frac{1}{2+j2} \right) = -1$$

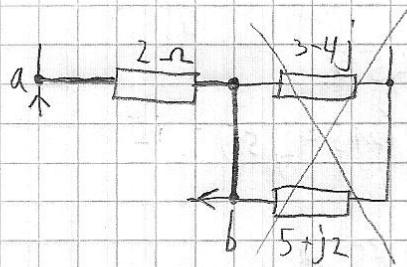
$$I = \frac{U_R}{1} = \frac{Y_1 - Y_2}{1}$$



$$U_T = U_{ab}$$

$$j4 = 3 + I_R$$

$$I_R = -3 + j4 \text{ A}$$



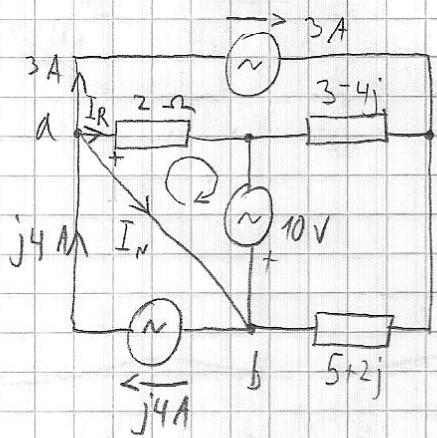
$$U_{ab} = -10 + I_R \cdot 2$$

$$= -10 - 6 + j8 = -16 + j8 \text{ V}$$

$$Z_n = Z_T = 2 \Omega$$

$$I_n = \frac{U_T}{R_T} = -8 + j4 \text{ A}$$

b) preko Nortonova



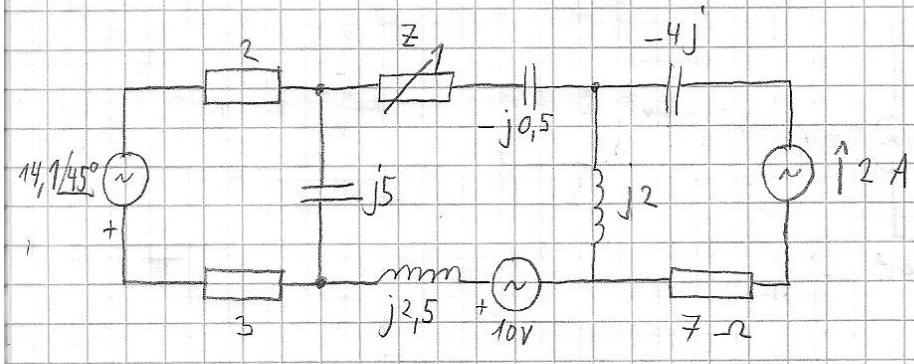
$$j4 = 3 + I_R + I_N$$

$$-2 I_R + 10 = 0$$

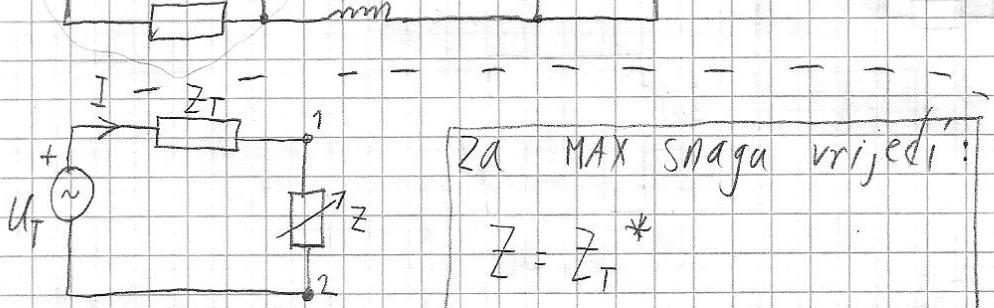
$$I_R = 5 \text{ A}$$

$$I_N = j4 - 3 - I_R$$

$$= -8 + j4 \text{ A}$$

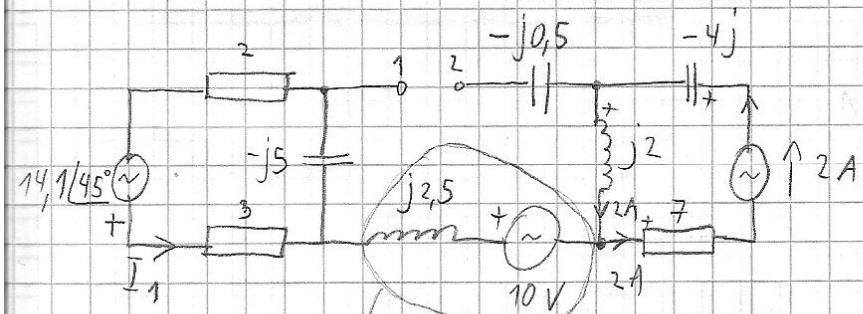


$$Z_T = -j0,5 + j2 + j2,5 + \frac{5(-j5)}{5-j5} = 2,5 - j1,5 \Omega$$



za MAX snagu vrijedi:

$$Z = Z_T$$



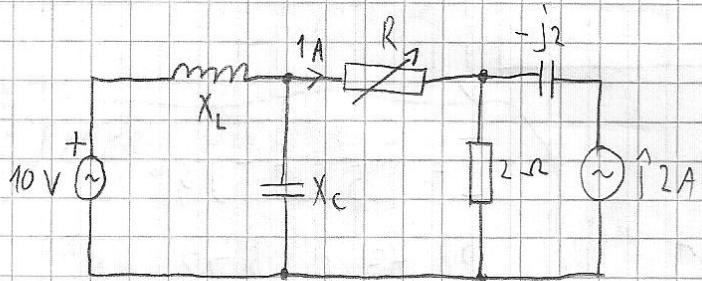
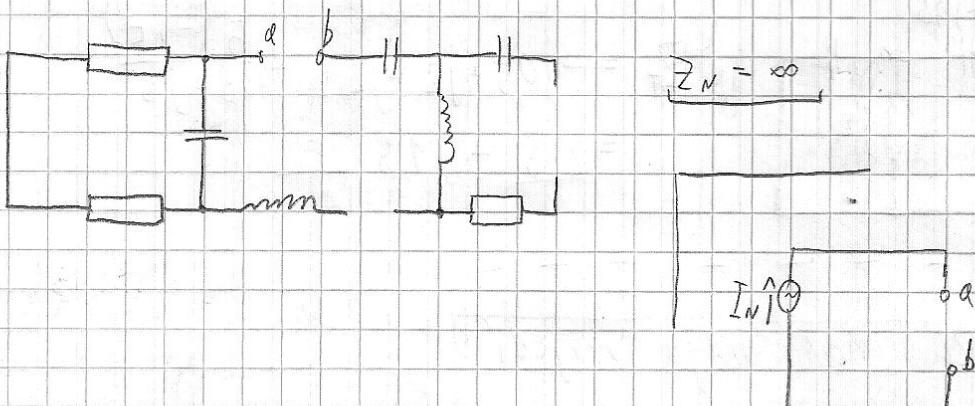
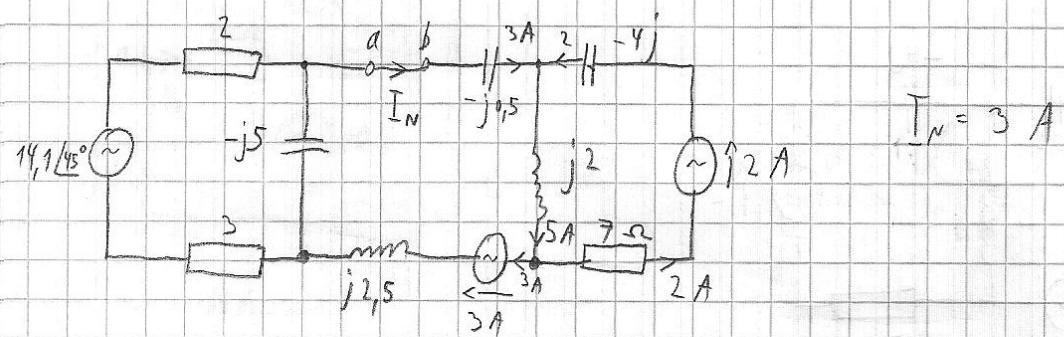
$$I = \frac{-j4}{5} = -j0,8$$

$$P = I^2 \cdot \text{Re}\{Z\}$$

$$= 0,64 \cdot 2,5 = 1,6 \text{ W}$$

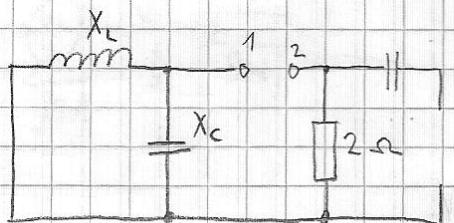
$$I_1 = \frac{14,1 \angle 45^\circ}{5-j5} = 2 \angle 90^\circ = j2 \text{ A}$$

$$U_T = U_{12} = -j4 + 10 - j2(-j5) = -j4 \text{ V}$$



$$I_N = 1 A$$

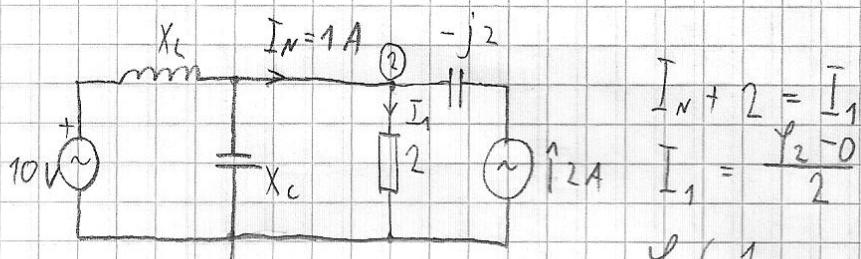
$$Z_N = \infty$$



$$Z_N = \frac{jX_L(-jX_C)}{jX_L - jX_C} + 2 = \infty$$

$$X_L - X_C = 0$$

$$X_L = X_C$$



$$I_N + 2 = I_1$$

$$I_1 = \frac{\varphi_2 - 0}{2}$$

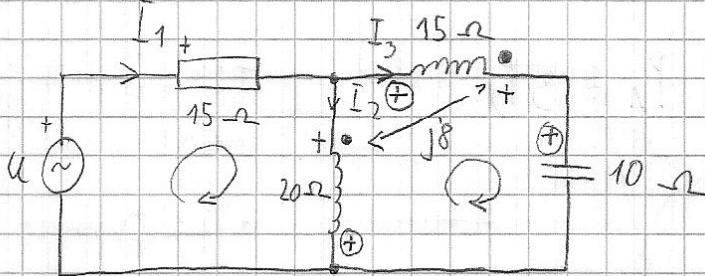
$$\varphi_2 \left( \frac{1}{jX_L} + \frac{1}{-jX_C} + \frac{1}{2} \right) = \frac{10}{jX_L} + 2$$

$$\varphi_2 = \frac{10}{jX_L} + 4$$

$$I_N = I_1 - 2 = \frac{10}{jX_L} + 2 - 2 = \frac{10}{jX_L}$$

$$|I_N| = 1 = \frac{10}{X_L} \rightarrow X_L = 10 \Omega$$

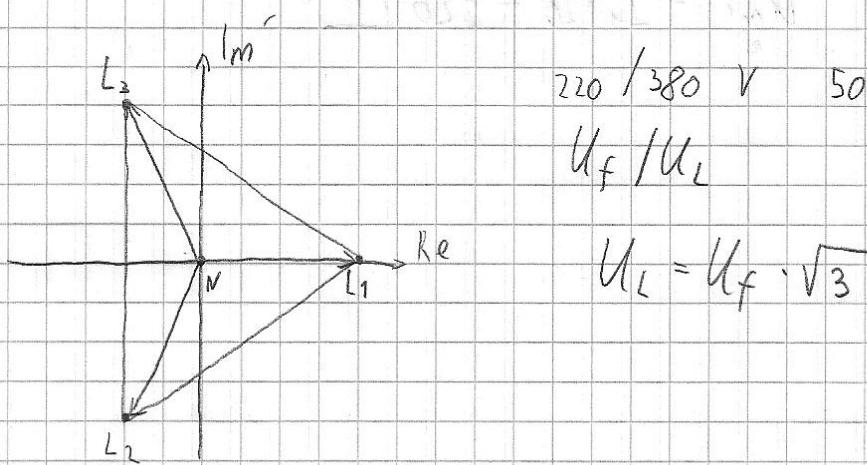
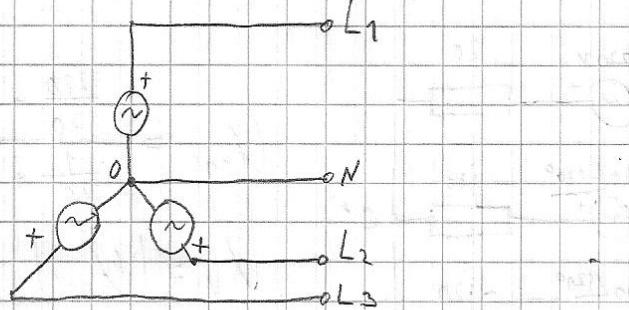
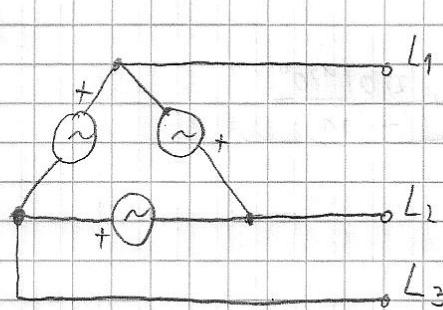
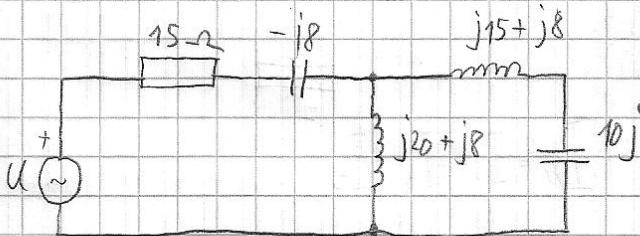
-  $X_C = 10 \Omega$



$$I_1 = I_2 + I_3$$

$$U - 15I_1 - j20I_2 + j8I_3 = 0$$

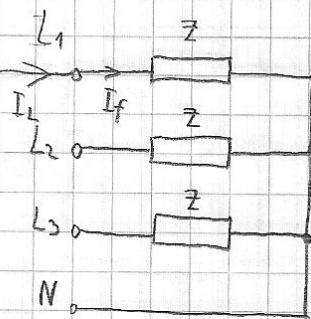
$$+ j20I_2 - j8I_3 - j15I_3 + j8I_2 - (j10)I_3 = 0$$



220 / 380 V 50 Hz  $\rightarrow$  G.M.

$U_f / U_L$

$$U_L = U_f \cdot \sqrt{3}$$

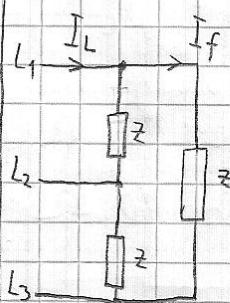


$$U_f = 220 \text{ V}$$

$$I_L = I_f$$

$$P_1 = U_f I_f \cos \varphi$$

$$P = 3 P_1$$

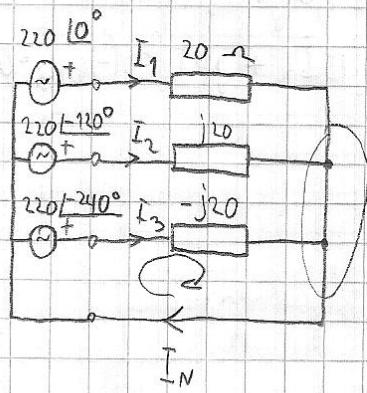


$$U_f = U_L = 380 \text{ V}$$

$$I_L = I_f \cdot \sqrt{3}$$

$$P_1 = U_f I_f \cdot \cos \varphi$$

$$P_d = 3 P_1$$



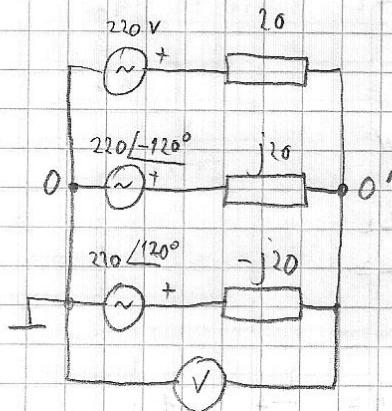
$$I_3 = \frac{220 \angle 120^\circ}{-j20}$$

$$I_2 = \frac{220 \angle -120^\circ}{j20}$$

$$I_1 = \frac{220 \angle 10^\circ}{20}$$

$$I_N = I_1 + I_2 + I_3$$

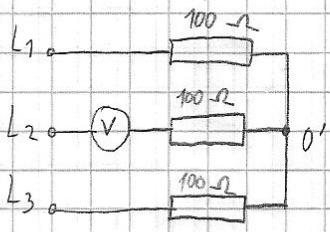
## PREKID NUL VODA



$$U_{00'} = \frac{\frac{220}{20} + \frac{220 \angle -120^\circ}{j20} + \frac{220 \angle 120^\circ}{-j20}}{\frac{1}{20} + \frac{1}{j20} + \frac{1}{-j20}}$$

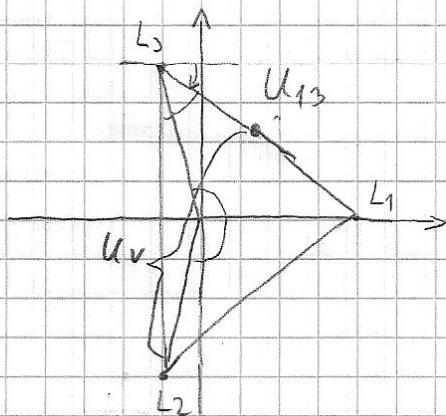
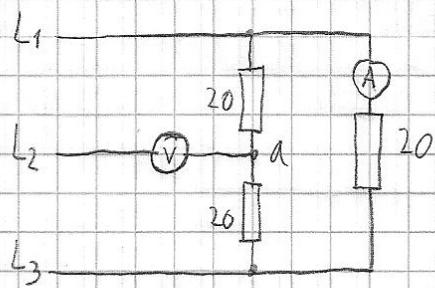
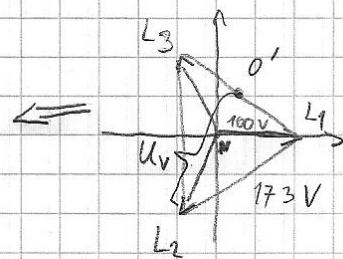
$$U_V = |U_{00'}|$$

$$U_{00'} = I_1 \cdot 20 - 220 \angle 0^\circ$$



12Vor linj skog naponia 173V

$$U_V = 150 \text{ V}$$



$$U_{13} = 173 \angle -30^\circ$$

$$I = \frac{173}{20}$$