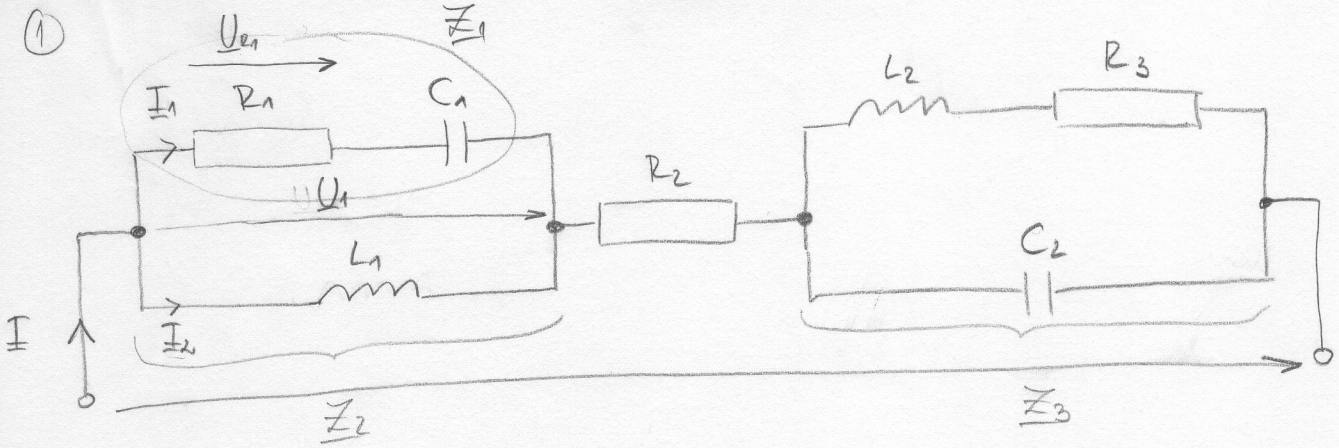
①



$\underline{U}_{R1} = 30 - j20\ V$ $\quad \underline{I} = ?$ $\quad \underline{I} = \underline{I}_1 + \underline{I}_2$

$R_1 = 10\ \Omega$

$R_2 = 20\ \Omega$

$R_3 = 30\ \Omega$

$X_{L1} = 10\ \Omega$

$X_{L2} = 20\ \Omega$

$X_{C1} = 20\ \Omega$

$X_{C2} = 10\ \Omega$

$$\underline{I}_1 = \frac{\underline{U}_{R1}}{R_1} = \frac{30 - j20}{10} = \boxed{3 - j2\ A}$$

$$\underline{U}_1 = \underline{I}_1 \cdot \underline{Z}_1 = (3 - j2)(10 - j20) = \boxed{-10 - j80\ V}$$

$$\underline{I}_2 = \frac{\underline{U}_1}{jX_{L1}} = \frac{-10 - j80}{j10} = \boxed{8 + j\ A}$$

$$\underline{I} = \underline{I}_1 + \underline{I}_2 = (3 - j2) + (-8 + j) = \boxed{5 - j\ A}$$

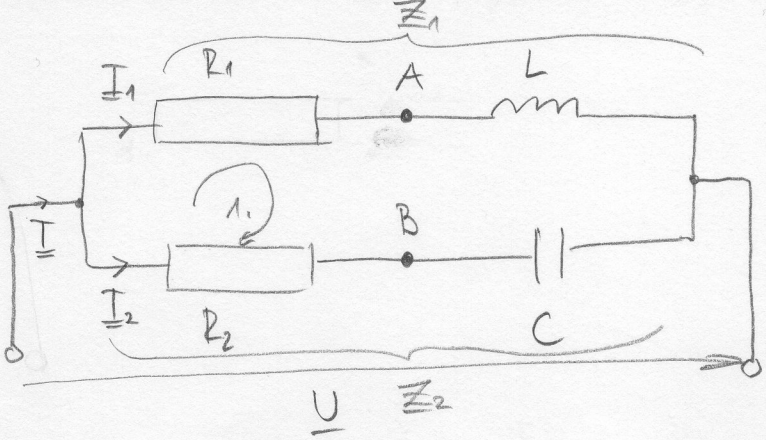
$\underline{Z} = ?$ $\quad \underline{Z} = \underline{Z}_2 + \underline{Z}_3 + R_2$

$$\underline{Z}_2 = \frac{\underline{Z}_1 \, jX_{L1}}{\underline{Z}_1 + jX_{L1}} = \frac{(10 - j20) \cdot j10}{(10 - j20) + j10} = \boxed{5 + j15\ \Omega}$$

$$Z_3 = \frac{(30 + j20) \cdot (-j10)}{30 + j20 - j10} = \boxed{3 - j11\ \Omega}$$

$$\underline{Z} = 5 + j15 + 3 - j11 + 20 = \boxed{28 + j4}$$

(2)



$\underline{U}_{AB} = ?$

$\underline{U} = 130\,V \quad \underline{Z}_1 = 8 + j6\ \Omega \quad \underline{Z}_2 = 12 - j5\ \Omega$

1) $\underline{U}_{R_1} + \underline{U}_{AB} - \underline{U}_{R_2} = \emptyset \qquad \underline{U} = \underline{I}_2 \cdot \underline{Z}_2 = \underline{I}_1 \underline{Z}_1$

$$\Rightarrow \underline{I}_1 = \frac{\underline{U}}{\underline{Z}_1} = \frac{130}{8+j6} = \boxed{10{,}4 - j7{,}8\ A}$$

$$\underline{I}_2 = \frac{\underline{U}}{\underline{Z}_2} = \frac{130}{12-j5} = \boxed{9{,}23 + j3{,}85\ A}$$

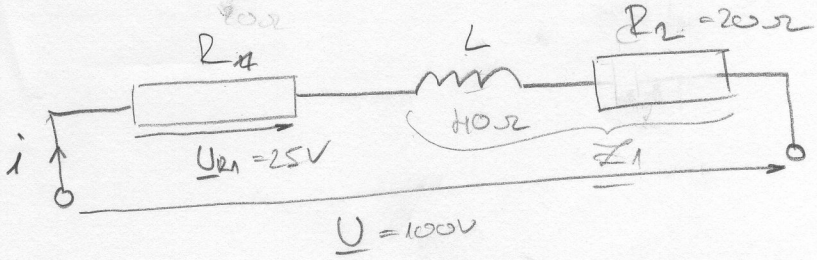
$$\underline{U}_{R_1} = \underline{I}_1 R_1 = (10{,}4 - j7{,}8) \cdot 8 = \boxed{83{,}2 - j62{,}4\ V}$$

$$\underline{U}_{R_2} = \underline{I}_2 \cdot R_2 = (9{,}23 + j3{,}85) \cdot 12 = \boxed{110{,}8 + j46{,}2\ V}$$

$$\underline{U}_{AB} = \underline{U}_{R_2} - \underline{U}_{R_1} = (110{,}8 + j46{,}2) - (83{,}2 - j62{,}4) = \boxed{27{,}6 + j108{,}6\ V}$$

$$= \boxed{112\, e^{j75{,}75^\circ}\ V}$$

(3)

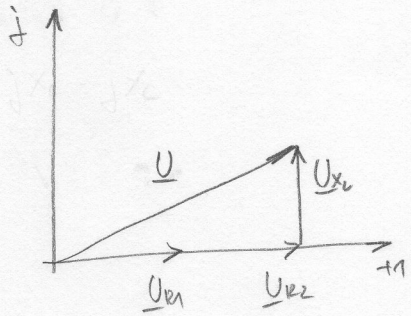


$\underline{U} = 100V$

$\underline{U}_{R1} = 25V$

$R_2 = 20\Omega$

$X_L = 40\Omega$



$\underline{Z} = ?$

$$\underline{U}^2 = (\underline{U}_{R1} + \underline{U}_{R2})^2 + \underline{U}_{XL}^2$$

$$\underline{I}_{R2} = \underline{I}_{XL}$$

$$\frac{U_{R2}}{R_2} = \frac{U_{XL}}{X_L} \Rightarrow \frac{U_{R2}}{U_{XL}} = \frac{R_2}{X_L} = \frac{20}{40} = \frac{1}{2} \Rightarrow U_{XL} = 2U_{R2}$$

$$U^2 = (U_{R1} + U_{R2})^2 + (2U_{R2})^2$$

$$100^2 = 25^2 + 50U_{R2} + U_{R2}^2 + 4U_{R2}^2$$

$$100^2 = 25^2 + 50U_{R2} + 5U_{R2}^2 \quad /:5$$

$$2000 = 125 + 10U_{R2} + U_{R2}^2$$

$$U_{R2}^2 + 10U_{R2} - 1875 = 0$$

$$U_{12} = \frac{-10 \pm \sqrt{10^2 - 4 \cdot (-1875)}}{2}$$

$U_1 = 38,37V$ ✓ $= U_{R2}$

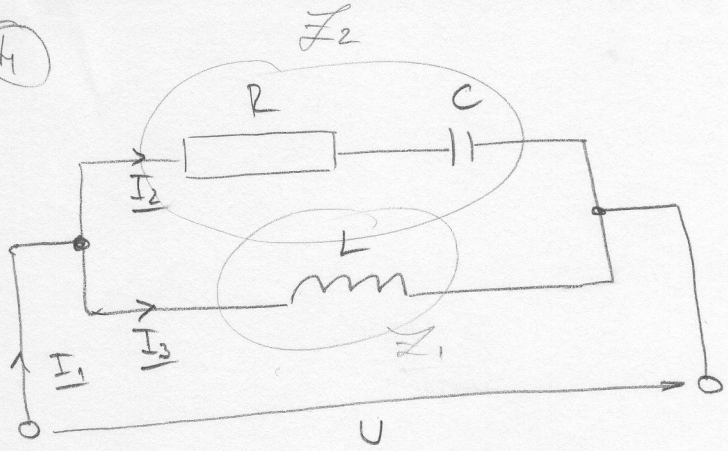
$U_2 = -48,37V$ nije ustvari

$$I = \frac{U_{R2}}{R_2} = \frac{38,37V}{20\Omega} = 1,9185A$$

$$R_1 = \frac{U_{R1}}{I} = \frac{25V}{1,9185A} = 13,03\Omega$$

$$\underline{Z} = R_1 + R_2 + jX_L = 33,03 + j40\Omega$$

(4)



$$\underline{I}_1 = \underline{I}_2 + \underline{I}_3$$

$$\underline{Z}_2 = \frac{U}{I_2} = \frac{100\,V}{7{,}21\,A} = \boxed{13{,}87\,\Omega}$$

zaostaje C

$$\underline{Z}_2 = Z_2\, e^{j\varphi_2} = \boxed{13{,}87 \cdot e^{-j\,56{,}29^\circ}}$$

$$\Downarrow$$

$$Re: 13{,}87 \cdot \cos\varphi_2$$

$$Im: 13{,}87 \sin\varphi_2$$

$$\underline{Z}_2 = R - jX_C =$$

$$= \boxed{7{,}7 - j\,11{,}54\,\Omega}$$

Izmjereni podaci:

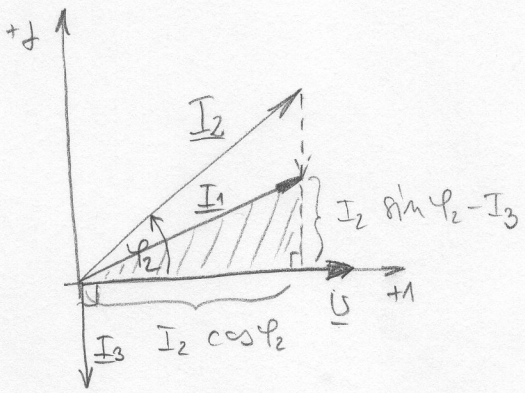
$I_1 = 5\,A$

$I_2 = 7{,}21\,A$

$I_3 = 3\,A$

$U = 100\,V$

$f = 100\,Hz$



$\underline{Z} = ?$

$$X_L = \frac{U}{I_3} = \boxed{33{,}33\,\Omega}$$

$$\underline{Z} = \frac{(R - jX_C) \cdot jX_L}{R - jX_C + jX_L}$$

$$\underline{Z} = \frac{(7{,}7 - j\,11{,}54) \cdot j33{,}33}{7{,}7 - j\,11{,}54 + j33{,}33}$$

$$\underline{Z} = \boxed{16{,}02 + j\,11{,}99\,\Omega}$$

$$I_1^2 = (I_2 \sin\varphi_2 - I_3)^2 + (I_2 \cos\varphi_2)^2$$

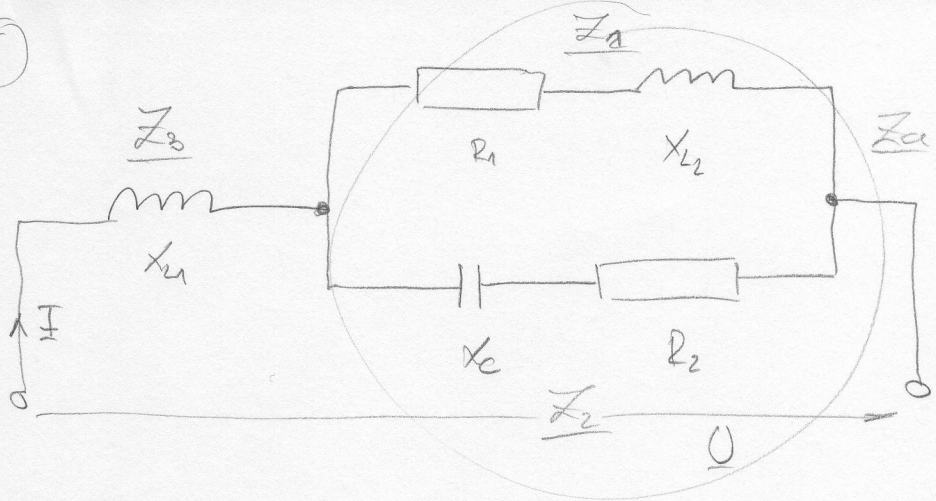
$$I_1^2 = I_2^2 \sin^2\varphi_2 - 2I_2 I_3 \sin\varphi_2 + I_3^2 + I_2^2 \cos^2\varphi_2$$

$$I_1^2 = I_2^2(\sin^2\varphi_2 + \cos^2\varphi_2) - 2I_2 I_3 \sin\varphi_2 + I_3^2$$

$$I_1^2 = I_2^2 + I_3^2 - 2I_2 I_3 \sin\varphi_2$$

$$\sin\varphi_2 = \frac{I_1^2 - I_2^2 - I_3^2}{2I_2 I_3} \Rightarrow \varphi_2 = \boxed{56\,29^\circ}$$

5)



$R_1 = 5\,\Omega$

$R_2 = 8\,\Omega$

$X_{L1} = 10\,\Omega$

X_{L2} 4 Ω

$X_C = 2\,\Omega$

$u = 100 \cdot e^{j30°}$

$\underline{I} = ?$

$\underline{Z_n} = ?$

$$\underline{U} = \frac{100}{\sqrt{2}} e^{j30°} = 50\sqrt{3} + j50 = 132{,}29\, e^{j22{,}21°}$$

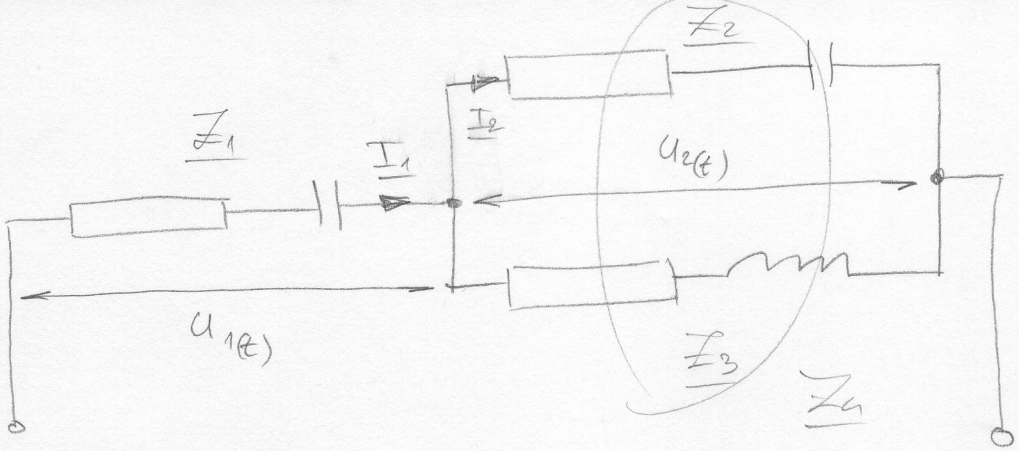
$$\underline{Z_4} = \frac{(5+j4)(8-j2)}{(5+j4)+(8-j2)} = 3{,}86 + j1{,}1\ \Omega$$

$$\underline{Z_n} = \underline{Z_4} + \underline{Z_3} = 3{,}86 + j11{,}1\ \Omega$$

$$\underline{I} = \frac{\underline{U}}{\underline{Z_n}} \quad \frac{50\sqrt{3}+j50}{3{,}86+j11{,}1} = 6{,}44 - j5{,}56\ A$$

$$= 8{,}51\, e^{-j40{,}82°}$$

(6)



$u_{2(t)} = 80 \cos(\omega t + 45^\circ)$

$\underline{Z_1} = 10 - j20\ \Omega$

$\underline{Z_2} = 20 - j10\ \Omega$

$\underline{Z_3} = 10 + j5\ \Omega$

$u_{1(t)} = ?$

$$\underline{U_2} = \frac{80}{\sqrt{2}} \cdot e^{j45} = 40 + j40$$

$$\underline{Z_a} = \frac{\underline{Z_2}\,\underline{Z_3}}{\underline{Z_2} + \underline{Z_3}} = \frac{(20 - j10)(10 + j5)}{(20 + j10) + (10 + j5)}$$

$$\underline{Z_a} = 8{,}11 + j1{,}35\ \Omega$$

$$\underline{I_1} = \frac{\underline{U_2}}{\underline{Z_a}} = \frac{40 + j40}{8{,}11 + j1{,}35} = \boxed{5{,}6 + j4\ A}$$

$$\underline{U_1} - \underline{I_1} \cdot \underline{Z_1} = (5{,}6 + j4) \cdot (10 - j20) = 136 - j72$$

$$= \boxed{153{,}88\, e^{-j27{,}9^\circ}}$$

$$\boxed{u_{1(t)} = 153{,}88\sqrt{2} \cdot \cos(\omega t - 27{,}9^\circ)}$$