

6. SINUSOIDALNE STRUJE I NAPONI

6.1. Impedancija i admitancija

Serijski spoj impedancija:

$$\underline{Z} = \underline{Z}_1 + \underline{Z}_2 + \underline{Z}_3 + \dots + \underline{Z}_n = \sum_{i=1}^n \underline{Z}_i \quad [\Omega] \quad (6.1)$$

Paralalni spoj impedancija:

$$\frac{1}{\underline{Z}} = \frac{1}{\underline{Z}_1} + \frac{1}{\underline{Z}_2} + \frac{1}{\underline{Z}_3} + \dots + \frac{1}{\underline{Z}_n} = \sum_{i=1}^n \frac{1}{\underline{Z}_i} \quad [\Omega] \quad (6.2)$$

Serijski spoj admitancija:

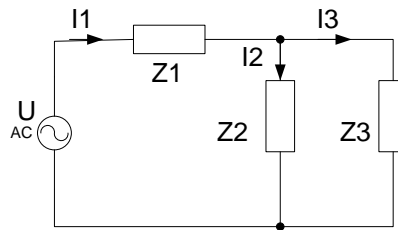
$$\frac{1}{\underline{Y}} = \frac{1}{\underline{Y}_1} + \frac{1}{\underline{Y}_2} + \frac{1}{\underline{Y}_3} + \dots + \frac{1}{\underline{Y}_n} = \sum_{i=1}^n \frac{1}{\underline{Y}_i} \quad [S] \quad (6.3)$$

Paralelni spoj admitancija:

$$\underline{Y} = \underline{Y}_1 + \underline{Y}_2 + \underline{Y}_3 + \dots + \underline{Y}_n = \sum_{i=1}^n \underline{Y}_i \quad [S] \quad (6.4)$$

AV6-Z1: U spoju (slika 6.1.) je $U = 20 \text{ V}$; $Z_1 = 4 + j8$; $Z_2 = 10e^{j37^\circ}$ i $Z_3 = 3 - j4$. Odrediti:

Z ; I_1 ; I_2 ; I_3 ; P .



Sl. 6.1.

Rješenje:

$$\underline{Z} = \underline{Z}_1 + \frac{\underline{Z}_2 \cdot \underline{Z}_3}{\underline{Z}_2 + \underline{Z}_3} = 8 + j6 = 10 / 36,86^\circ (\Omega)$$

$$\underline{I}_1 = \frac{U}{\underline{Z}} = \frac{20 / 0^\circ}{10 / 36,86^\circ} = 1,6 - j1,2 = 2 / -36,86^\circ (\text{A})$$

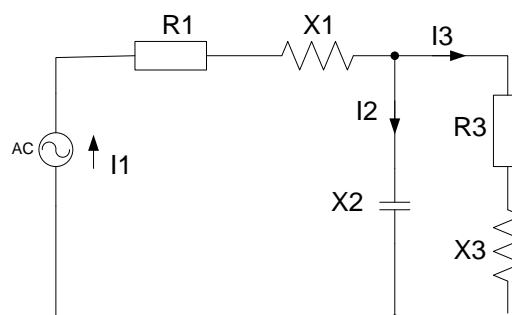
$$\underline{I}_2 = \frac{U - \underline{I}_1 \cdot \underline{Z}_1}{\underline{Z}_2} = \frac{20 - (1,6 - j1,2) \cdot (4 + j8)}{10 / 37^\circ} = -0,16 - j0,88 = 0,9 / -100,4^\circ (\text{A})$$

$$\underline{I}_3 = \underline{I}_1 - \underline{I}_2 = 1,76 - j0,32 = 1,8 / -10,3^\circ (\text{A})$$

$$\underline{S} = \underline{U} \cdot \underline{I}_1^* = 20 / 0^\circ \cdot 2 / 36,86^\circ = 32 + j24 (\text{VA})$$

$$P = 32 (\text{W})$$

AV6-Z2: U krugu (slika 6.2.) zadano je: $R_1 = 2 \Omega$; $X_1 = 26 \Omega$; $R_3 = 10 \Omega$; $X_3 = 10 \Omega$; $X_2 = -10 \Omega$. Spoj troši $P = 1,2 \text{ kW}$. Izračunati Z ; I_1 ; I_2 i I_3 .



Sl. 6.2.

Rješenje:

$$\underline{Z} = R_1 + jX_1 + \frac{-jX_2 \cdot (R_3 + jX_3)}{-jX_2 + R_3 + jX_3} = 12 + j16 = 20 / 53,13 \text{ } (\Omega)$$

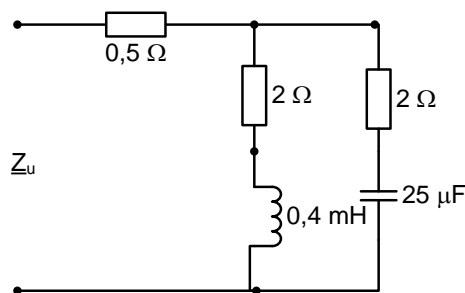
$$P = I_1^2 \cdot \text{Re}(\underline{Z}) \Rightarrow I_1 = \sqrt{\frac{P}{\text{Re}(\underline{Z})}} = 10 \text{ (A)} \Rightarrow I_1 = 10 / 0^\circ \text{ (A)}$$

$$\underline{U}_2 = I_1 \cdot \frac{-jX_2 \cdot (R_3 + jX_3)}{-jX_2 + R_3 + jX_3} = 100 + j100 = 141,42 / 45^\circ \text{ (V)}$$

$$\underline{I}_2 = \frac{\underline{U}_2}{-jX_2} = 10 + j10 = 14,14 / 45^\circ \text{ (A)}$$

$$\underline{I}_3 = I_1 - \underline{I}_2 = -j10 = 10 / -90^\circ \text{ (A)}$$

AV6-Z3: Treba odrediti ulaznu impedanciju u shemi na slici 6.3., ako je $\omega = 5000 \text{ rad/s}$.



Sl. 6.3.

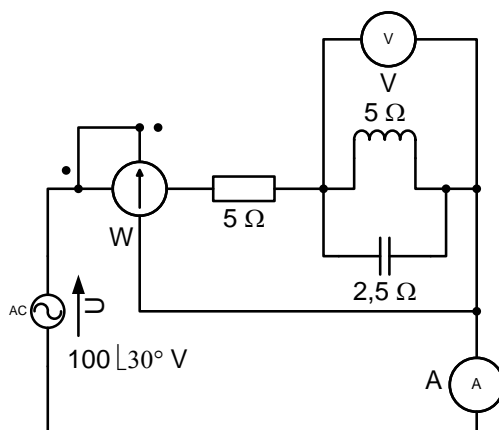
Rješenje:

$$X_C = \frac{1}{\omega C} = 8 \text{ } (\Omega); \quad X_L = \omega L = 2 \text{ } (\Omega); \quad \underline{Z}_2 = R_2 + jX_L = 2 + j2 \text{ } (\Omega)$$

$$\underline{Z}_3 = R_3 - jX_C = 2 - j8 \text{ } (\Omega); \quad \underline{Z}_{23} = \frac{\underline{Z}_2 \cdot \underline{Z}_3}{\underline{Z}_2 + \underline{Z}_3} = 2,92 + j1,38 \text{ } (\Omega)$$

$$\underline{Z}_u = R_1 + \underline{Z}_{23} = 3,42 + j1,38 = 3,7 / 22^\circ \text{ } (\Omega)$$

AV6-Z4: Koje vrijednosti pokazuju instrumenti na slici 6.4.?

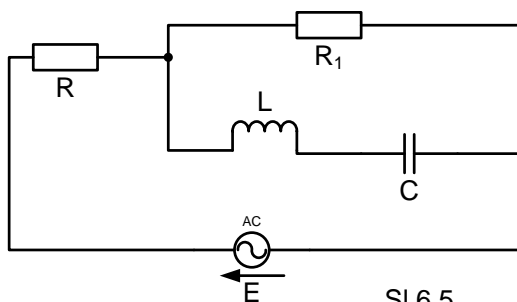


Sl. 6.4.

Rješenje:

$$P_W = 1000 \text{ (W)}; \quad U_V = 71,71 \text{ (V)}; \quad I_A = 14,14 \text{ (A)}$$

AV6-Z5: U mreži na slici 6.5. treba odrediti: otpor R , napone U_L i U_C ako je zadano: $\underline{E} = 100 \angle 0^\circ \text{ V}$, $\underline{I} = 1 \angle -18^\circ \text{ A}$, $\omega = 400 \text{ rad/s}$, $R_1 = 30 \Omega$, $L = 225 \text{ mH}$, $C = 50 \mu\text{F}$.



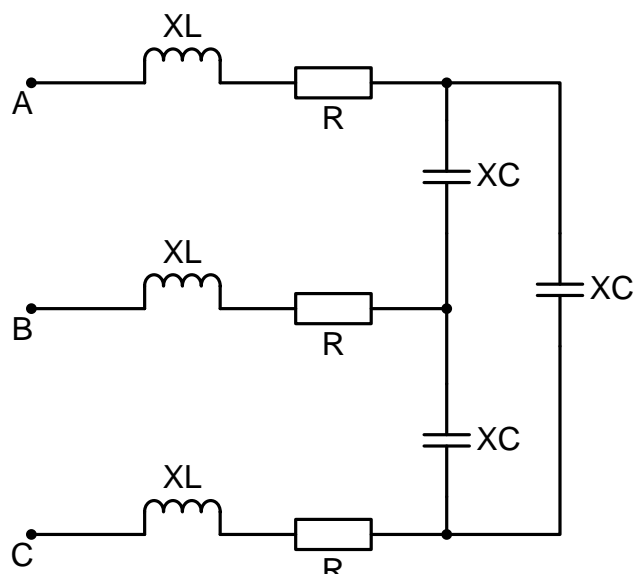
Sl.6.5.

Rješenje:

$$R = 25,11 \text{ (}\Omega\text{)}; \quad \underline{U}_L = 109,65 + j37,47 = 115,88 / 18,87^\circ \text{ (V)}$$

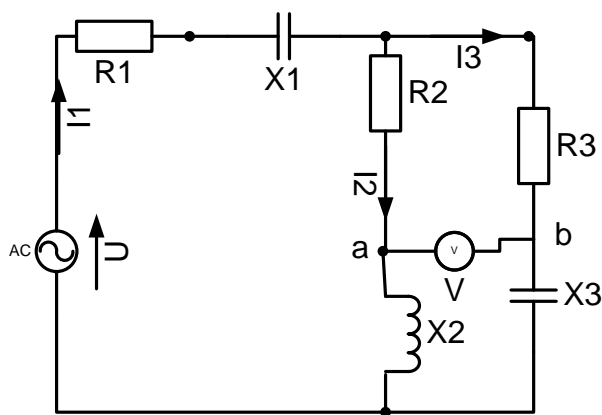
$$\underline{U}_C = -60,91 - j20,82 = 64,38 / -161,13^\circ \text{ (V)}$$

AV6-Z6: U mreži na SLICI 6.6 zadano je $X_L = 9 \Omega$ i $R = 3 \Omega$. Nađite X_C tako da ulazna impedancija mreže gledana s bilo kojih stezaljki bude radni otpor.

**Rješenje:**

$$X_C = 27 \text{ } (\Omega)$$

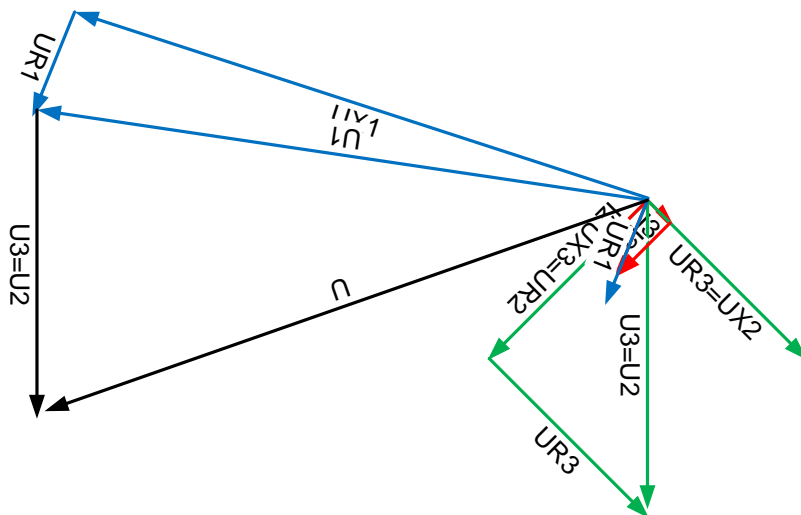
AV6-Z7: Mreži na slici 6.7 je $R_1 = 2 \text{ } \Omega$, $X_1 = 8 \text{ } \Omega$, $X_2 = 5 \text{ } \Omega$, $R_2 = 5 \text{ } \Omega$, $R_3 = 10 \text{ } \Omega$, $X_3 = 10 \text{ } \Omega$ i $U_{ab} = 20 \text{ V}$. Odredite I_1 , I_2 , I_3 , U , P i nacrtajte fazorski dijagram.

**Rješenje:**

$$\underline{Z} = 8 - j6 \text{ } (\Omega); \underline{I}_1 = -1 - j3 = 3,16 / -108,4^\circ \text{ (A)}; \underline{I}_2 = -2 - j2 = 2,82 / -135^\circ \text{ (A)}$$

$$\underline{I}_3 = -1 - j3 = 1,41 / -45^\circ \text{ (A)}; \underline{U} = -26 - j18 = 31,62 / -145,3^\circ \text{ (V)}; P = 80 \text{ (W)}$$

Fazorski dijagram prikazuje slika 6.8



Slika 6.8

LITERATURA

- [1] Branislav Kuzmanović, „Osnove elektrotehnike II“, Zagreb ELEMENT, 2000
- [2] Ivan Felja-Danira Koračin, „Zbirka zadataka i rješениh primjera iz osnova elektrotehnike 1. i 2. dio“, Zagreb, Školska knjiga 1985.
- [3] Gordan Đurović, „Elektrotehnika I i II-Zbirka zadataka, Zagreb, 2004.
- [4] E. Šehović, M. Tkalić, I. Felja, Osnove elektrotehnike - zbirka primjera, I dio“, Školska knjiga, Zagreb, 1984.