1.1-2. IMPEDANCIJA I ADMITACIJA

IMPEDANCIJA - omjer fazora napona $\dot{u}$ i fazora struje $\dot{I}$

↳ kompleksni broj = $\underline{Z}$ impedancija

$$\underline{Z} = \frac{\dot{u}}{\dot{I}}$$ fazor napona / fazor struje

$$* \quad u_{ef} = \frac{u_m}{\sqrt{2}} = |\dot{u}|$$

$$\dot{u} = |\dot{u}| \angle \alpha$$

$$\underline{Z} = \frac{|\dot{u}| \angle \alpha_u}{|\dot{I}| \angle \alpha_i} = |\underline{Z}| \angle \varphi = |\underline{Z}| \cos\varphi + j|\underline{Z}| \sin\varphi = \underline{R \pm jX}$$ kompleksni

↳ modul impedancije $|\underline{Z}| = \sqrt{R^2 + X^2}$

Realni dio: OTPOR $R = |\underline{Z}| \cos\varphi$ → možemo izmjeriti

Imaginarni dio: REAKTANCIJA $X = |\underline{Z}| \sin\varphi$ -> ! računamo !

[OHM]

$-Z, R, X$

↳ može biti: induktivna : $X_L = \omega L$ (predznak +)

kapacitativna: $X_C = \frac{1}{\omega C}$ (-||- -)

▶ Karakteri impedancije (5)

I. čisti induktivni otpor ($\varphi = +90°$)

$$\underline{Z} = \frac{\dot{u}}{\dot{I}} = \frac{|\dot{u}| \angle \alpha_u}{|\dot{I}| \angle \alpha_i} = X_L \angle +\frac{\pi}{2} = j \cdot X_L$$

II. impedancija s induktivnim karakterom

$$\underline{Z} = \frac{\dot{u}}{\dot{I}} = \frac{|\dot{u}| \angle \alpha_u}{|\dot{I}| \angle \alpha_i} = \boxed{|\underline{Z}| \angle \varphi}$$ uz uvjet: $0 < \varphi < +90°$

induktivni otpor

↳ impedanciju unutar dvopola možemo svest na $\underline{Z} = R + jX_L$

III. čisti omski otpor ($\varphi = 0°$)

$$\underline{Z} = \frac{\dot{u}}{\dot{I}} = \frac{|\dot{u}| \angle \alpha_u}{|\dot{I}| \angle \alpha_i} = R \angle 0° \stackrel{!}{=} \boxed{R}$$

IV. impedancija s kapacitivnim karakt.

$$\underline{Z} = \frac{\dot{U}}{\dot{I}} = \frac{|U|\angle\alpha_u}{|I|\angle\alpha_i} = |Z|\angle\varphi$$

uz uvjet $-90° < \varphi < 0°$

↳ kapacitivni otpor $\underline{Z} = R - jX_c$

V. čisti kapacitivni otpor ($\varphi = -90°$)

$$\underline{Z} = \frac{\dot{U}}{\dot{I}} = \frac{|U|\angle\alpha_u}{|I|\angle\alpha_i} = X_c\angle -90°$$

$$\underline{Z} = -jX_c$$

Trokut impedancije

$\underline{Z} = R + jX$ vrijedi:

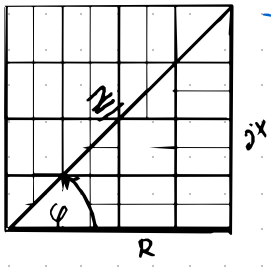
$\mathrm{Re}\{\underline{Z}\} = R$, $R \geq 0$

$\mathrm{Im}\{\underline{Z}\} = X$, $X \geq 0$ ili $X \leq 0$

impedancija → ~~FAZOR~~

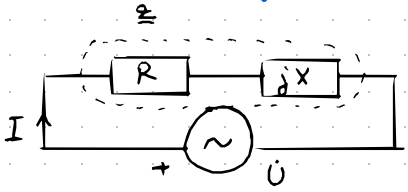
↓

kompleksan broj



→ φ (kut impedancije ili fazni pomak) između napona i struje na impedanciji

↳ $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$



ADMITACIJA: kvocijent fazora struje i napona

$$\underline{Y} = \frac{\dot{I}}{\dot{U}} = \frac{|I|\angle\alpha_i}{|U|\angle\alpha_u} = |\underline{Y}|\angle\varphi = |\underline{Y}|\cos\varphi + j|\underline{Y}|\sin\varphi = G + jB$$

$$|\underline{Y}| = Y = \sqrt{G^2 + B^2}$$

kut admitacije $= \varphi = \alpha_i - \alpha_u = \mathrm{arctg}\left(\frac{B}{G}\right) = -\varphi$

Realni dio: VODLJIVOST G

Imaginarni dio: SUSCEPTIBILNOST B

↳ može biti - induktivna $B_L = \frac{1}{\omega_L}$ (−)

- kapacitivna $B_C = \omega_C$ (+)

[SIMENS]

- Y, G, B

Ako su otpor i vodljivost: $\underline{Z} = \frac{1}{G}$

→ slično su impedancija i admitancija

$$\underline{Y} = \frac{1}{\underline{Z}} \qquad G = \frac{1}{R}$$

$$|\underline{Y}|\angle\varphi = \frac{1}{|\underline{Z}|\angle\varphi} \qquad B_L = \frac{1}{X_L} = \frac{1}{\omega L}$$

$$\angle\varphi = -\angle\varphi \qquad B_C = \frac{1}{X_C} = \omega C$$

▶ Karakteri admitancije (5)

I. čista induktivna susceptibilnost ($\varphi = -90°$)

$$\underline{Y} = \frac{\dot{I}}{\dot{U}} = \frac{|\dot{I}|\angle\alpha_i}{|\dot{U}|\angle\alpha_u} = B_L\angle -90° = -jB_L = -j\frac{1}{\omega L}$$

II. admitancija s induktivnim karakterom

$$\underline{Y} = \frac{\dot{I}}{\dot{U}} = \frac{|\dot{I}|\angle\alpha_i}{|\dot{U}|\angle\alpha_u} = |\underline{Y}|\angle\varphi \quad \text{uz uvjet } -90° < \varphi < 0$$

· pravadava induktivna susceptibilnost → $\boxed{\underline{Y} = G - jB_L}$

III. čista omska vodljivost G ($\varphi = 0°$)

$$\underline{Y} = \frac{\dot{I}}{\dot{U}} = \frac{|\dot{I}|\angle\alpha_i}{|\dot{U}|\angle\alpha_u} = G\angle 0° = G$$

IV. admitancija s kapacitivnim karakterom:

$$\underline{Y} = \frac{\dot{I}}{\dot{U}} = |\underline{Y}|\angle\varphi \quad \text{uz uvjet: } 0 < \varphi < +90°$$

· kapacitativna susceptibilnost → $\boxed{\underline{Y} = G + jB_C}$

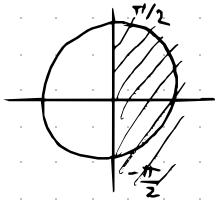
V. čista kapacitivna susceptibilnost ($\varphi = 90°$)

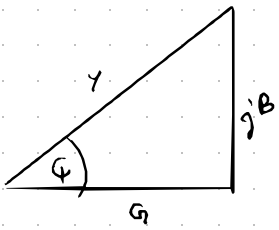
$$\underline{Y} = \frac{\dot{I}}{\dot{U}} = \frac{|\dot{I}|\angle\alpha_i}{|\dot{U}|\angle\alpha_u} = B_C\angle +90° = jB_C = j\omega C$$

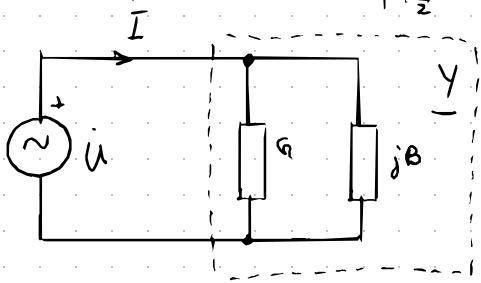
Trokut admitacije

$\mathrm{Re}\{\underline{Y}\} = G \quad , \; G \geq 0$

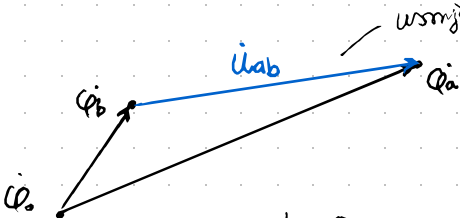
$\mathrm{Im}\{\underline{Y}\} = B \quad , \; B \geq 0 \text{ ili } B \leq 0$







NAPONI I POTENCIJALI U KOMPLEKSNOJ RAVNINI

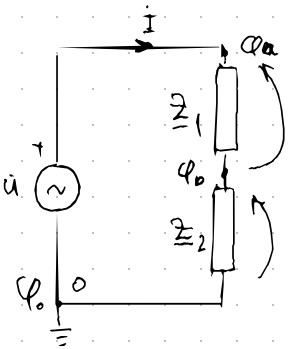


$\Rightarrow \dot{U}_{ab} = \dot{\varphi}_a - \dot{\varphi}_b = \dot{\varphi}_a + (-\dot{\varphi}_b)$

$\downarrow$

$\dot{\varphi}_a = \dot{U}_{ab} + \dot{\varphi}_b$

$\downarrow \dot{\varphi}_0 = 0 + j0 = 0\,V$



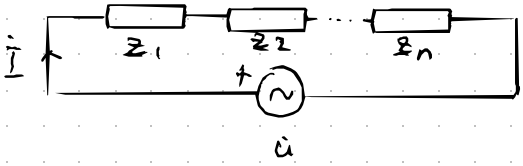
slijedi

$\dot{U}_{ab} = \dot{\varphi}_a - \dot{\varphi}_b$

$\dot{U}_{ba} = \dot{\varphi}_b - \dot{\varphi}_a$

$\dot{U}_{ab} = -\dot{U}_{ba}$

SERIJSKI SPOJ IMPEDANCIJA



$\rightarrow Z_{uk} = Z_1 + Z_2 + \dots Z_n$

(kao otpore)

SERIJSKI SPOJ ADMITACIJA $\underline{Y} = \left(\frac{1}{Y_1} + \frac{1}{Y_2} + \dots \frac{1}{Y_n} \right)^{-1}$

(kao kondenzatore)

PARALELNI SPOJ IMPEDANCIJA: $Z_{uk} = \left(\frac{1}{Z_1} + \frac{1}{Z_2} - \frac{1}{Z_n} \right)^{-1}$

PAR. SPOJ. ADMITACIJA: $\underline{Y} = Y_1 + Y_2 \dots Y_n$