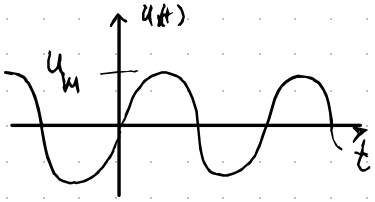
5. Izmjenične veličine



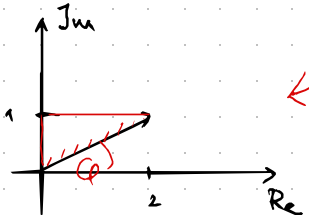
$u(t) = U_m \sin(\omega t + \varphi)$

$\underline{u} = U_{ef} \angle \varphi$ — FAZOR

$U_{ef} = \frac{U_m}{\sqrt{2}}$

FAZOR = kompleksni broj

elektrotehnički zapis



$z = 2 + i$ → ne koristimo ovu formu jer je množenje i dijeljenje lakše u sin/cos

$(a + bi)$

$u_1 = 2 \angle 90$

$I_1 = 3 \angle 30$

$u_1 \cdot I_1 = 2 \cdot 3 \angle 90 + 30 = 6 \angle 120$

$R = \frac{u}{I} = \frac{2}{3} \angle 60$

inače:

$|z| = \sqrt{a^2 + b^2}$

$\varphi = \pm \operatorname{tg}^{-1}\left(\frac{b}{a}\right)$

$a = |z| \cos\varphi$

$b = |z| \sin\varphi$

ali to za nas odrađuje CASIO

ZADACI

① DEK 18./19. -1

$|\dot{U}| = ?$ $\quad u(t) = U_m \sin(\omega t + \alpha)$ $\quad u(t) = u_1(t) + u_2(t)$

$u_1(t) = 3\sin(\omega t)$ $\quad u_2(t) = 4\sin(\omega t - \pi/2)$

~~$u = 3\sin(\omega t) + 4\sin(\omega t - \frac{\pi}{2})$~~ → komplicirano!

Napravi fazore:

$$\dot{U}_1 = \frac{3}{\sqrt{2}} \angle 0° \qquad \dot{U}_2 = \frac{4}{\sqrt{2}} \angle -90°$$

$u = 2{,}5\sqrt{2} \angle -0.9273_{rad}$

$\dot{u} = (2{,}5\sqrt{2}) \angle -53{,}13°$ $\xrightarrow{u_{ef}}$ $U_m = U_{ef} \cdot \sqrt{2} = 5\,V$

$$\boxed{u(t) = 5 \cdot \sin(\omega t - 53{,}13°)}$$ ✓

② MI 18/19. -2

$\dot{I} = 2\sqrt{2} \angle 30°$ $\quad i(t) = I_m \sin(\omega t + \varphi)$

$I_{ef} \cdot \sqrt{2} = I_m \rightarrow 2\sqrt{2} \cdot \sqrt{2} = \underline{4}$ $\quad \varphi = 30°$

$t_1 = 15\,ms$

$f = 50\,Hz$

$i(t_1) = ?$

$\omega = 2\pi f$

$\omega = 2\pi \cdot 50\,Hz$

$\omega = 314{,}16\,Hz$

$i(15 \times 10^{-3}) = 4\sin(314{,}16 \cdot 15 \times 10^{-3} + 30)$ $\quad \frac{\pi}{6}!$

$$\boxed{i(t_1) = -2\sqrt{3} = -3{,}46\,A}$$ ✓

④ $\dot{I} = (2+j2)/(2-j2)$ $\quad i(t) = ?$

$t = 0s$

$$\dot{I} = \frac{2+2j}{2-2j} = \frac{(2+2j)^2}{4-4\cdot(-1)} = \frac{4+8j-4}{8} = 1j$$

$\dot{I} = 1 \angle \frac{1}{2}\pi = 1 \angle 90°$

$\sqrt{2} = I_{max} \rightarrow i(t) = \sqrt{2}\sin(\omega t^{0} + \frac{\pi}{2}) = \sqrt{2}\,A$ ✓

5. WIR-2021.-

$\dot{I} = I_{ef} \angle 45°$ $\quad |\dot{I}| \Rightarrow$ $\quad i(t) = I_m \sin(\omega t + \varphi)$

$t = 30 \times 10^{-3}\,s$

$-7{,}5A = I_m \cdot \sin\left(100\pi \cdot 30 \times 10^{-3} + \frac{\pi}{4}\right)$ [A]

$i(30\,ms) = -7{,}5A$

$I_m = 7{,}5\sqrt{2} \rightarrow \boxed{I_{ef} = 7{,}5A}$

$f = 50Hz \longrightarrow \omega = 2\pi \cdot 50$ $\quad \boxed{\dot{I} = 7{,}5 \angle 45°}$

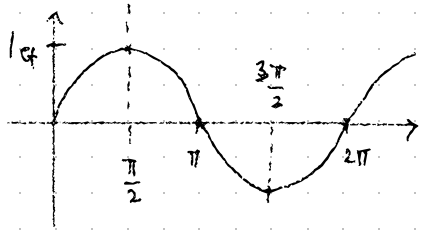
6.

$i(t) = I_m \sin \omega t$

$f = 50Hz$

$t_0 = 0$

$i(t) = I_{ef} \rightarrow t = ?$



~~$\varphi = \frac{\pi}{2} = 90°$~~

$\omega = 100\pi$

nema pomaka

$I_m = I_{ef} \cdot \sqrt{2} \rightarrow$ ~~$i(t) = I_{ef} \cdot \sqrt{2} \cdot \sin(100\pi + \frac{\pi}{2})$~~

$\frac{\sqrt{2}}{2} = \frac{1}{\sqrt{2}} = \sin\left(100\pi \cdot t + \frac{\pi}{2}\right) \Big/ \arcsin$

$\frac{1}{4}\pi = 100\pi \cdot t + \frac{\pi}{2}$

$+\frac{1}{4}\pi = 100\pi \cdot t \;/ \cdot 100\pi \rightarrow t = \frac{+1}{400}\,s = 2{,}5 \times 10^{-3}\,s$

13.

$I_m = 5\sqrt{2}A$ $\quad i(t) = I_m \sin(\omega t + \varphi)$

$t = \frac{5\pi}{8} \times 10^{-3}\,s$ $\quad \longrightarrow = 5\sqrt{2}(\omega t + \varphi)$

$T = \pi_{ms} \rightarrow T = \frac{2\pi}{\omega} \rightarrow \omega = \frac{2\pi}{\pi \times 10^{-3}}$ $\quad \Rightarrow$ ~~$5\sqrt{2} = 5\sqrt{2}\sin(2000 \cdot \frac{5\pi}{8}\,ms + \varphi)$~~

$i(t) = ?$ $\quad \omega = 2000$

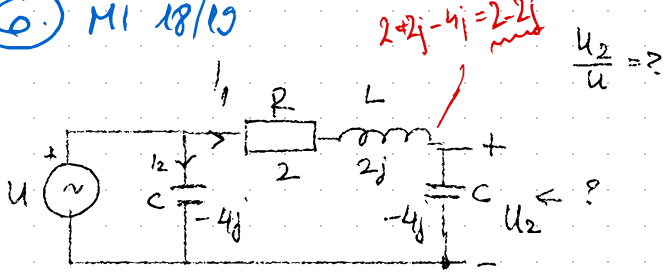
$\frac{\pi}{2} = 2000 \cdot \frac{5\pi}{8} \cdot 10^{-3} + \varphi$

$\frac{\pi}{2} = \frac{5\pi}{4} + \varphi \rightarrow \varphi = \frac{-3\pi}{4}$

$\Rightarrow \boxed{i(t) = 5\sqrt{2}\sin\left(2000t - \frac{3\pi}{4}\right)}$

ZADACI – zavojnice i kondenzatori

(6.) MI 18/19



$R = 2\,\Omega$

$L = 0{,}02\,H \rightarrow j \Rightarrow X_L = j\omega L = j \cdot 100 \cdot 0{,}02 = \underline{2j}$

$C = 2{,}5\,mF \rightarrow -j \Rightarrow X_C = -j\frac{1}{\omega C} = -j \cdot \frac{1}{100 \cdot 25 \times 10^{-3}} = \underline{-4j}\,\Omega$

$\omega = 100\,rad/s$

$\frac{U_2}{U} \Rightarrow U_2 = I_1 \cdot C$

$I = \frac{U}{R_{uk}} \rightarrow U = \underline{I} \cdot R_{uk}$

$U_2 = I_1 \cdot (-4j)$

$R_{uk} = \left(\frac{1}{-4j} + \frac{1}{2+2j-4j}\right)^{-1} = \left(\frac{1}{-4j} + \frac{1}{2-2j}\right)^{-1}$

$\underline{R_{uk} = \frac{4\sqrt{5}}{5}\angle -63{,}43^\circ}$

Strujno dijelilo: + ima u formulama
– struja koja nas zanima (I_1) će biti ukupna struja × grana koja nas ne zanima ÷ sama te druge grane

$\frac{U_2}{U} = \frac{I_1(-4j)}{1 \cdot R_{uk}} = \frac{\cancel{1} \cdot \frac{-2j \cdot (-4j)}{2-3j}}{\cancel{1} \cdot \frac{4\sqrt{5}}{5}\angle -63{,}43^\circ}$

$\hookrightarrow I_1 = 1 \cdot \frac{-4j}{(-4j)\,//\,(2-2j)}$

$\frac{U_2}{U} = \frac{\frac{-8}{1-3j}}{\frac{4\sqrt{5}}{5}\angle -63{,}43^\circ} = \boxed{\sqrt{2}\angle -45^\circ}$

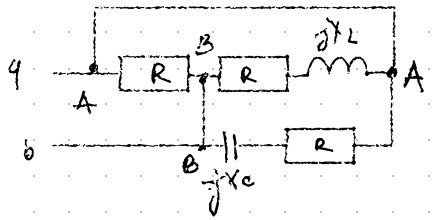
$I_1 = 1 \cdot \frac{-4j}{2-6j} = 1 \cdot \frac{-2j}{1-3j}$

↳ (1+1)

8. DEK 18./19.

$R = X_L = X_C = 60\ \Omega$

$Z_{ab} = ?$



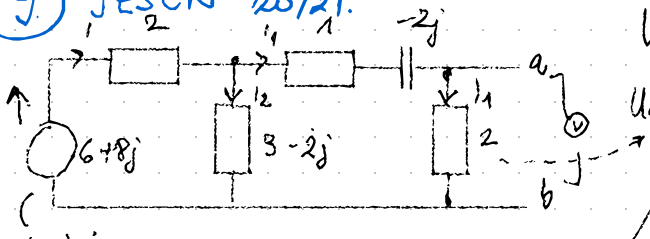
→ vidimo da su to tri paralele (mi smo dodali A i B)

↳ između istih potencijala su: R, $R + jX_L$, jX_C i R

$$Z_{ab} = \left(\frac{1}{R} + \frac{1}{R+jX_L} + \frac{1}{R-jX_C}\right)^{-1}$$

$$Z_{ab} = \left(\frac{1}{60} + \frac{1}{60+60j} + \frac{1}{60-60j}\right)^{-1} = 30\ \Omega$$

9. JESEN 20/21.



$U_{ab} = ?$

$U_{ab} = I_1 \cdot 2\ \Omega$

(strujni izvor)

$$I_1 = 1 \cdot \frac{3-2j}{3-2j+1+2-2j}$$

$$U_{ab} = (6+8j)\,\frac{3-2j}{6-4j} \cdot 2\ \Omega = 10\angle 53{,}13^\circ$$

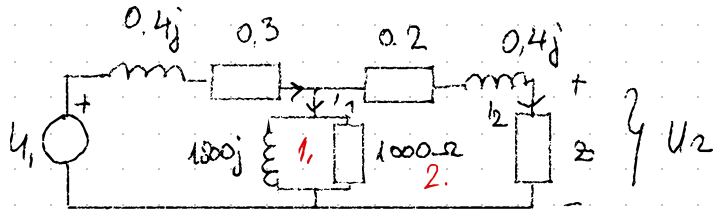
modul

3. MI 18./19.

$U_2 = 1000\angle 0°$

$I_2 = 10\angle -30°$

$U_1 = ?$



$$Z = \frac{U_2}{I_2} = \frac{1000\angle 0°}{10\angle -30°} = 100\angle 30°$$

Želimo doći do I

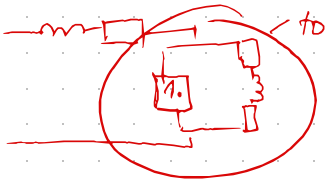
Izrazimo djelilo:

$I = I_1 + I_2$

$U_1 = I \cdot Z_{uk}$

1.) $Z_p = \left(\frac{1}{1500j} + \frac{1}{1000}\right)^{-1} = 832,05\angle 33,69°$

2.)



to je paralela

$$Z_2 = \left(\frac{1}{Z_p} + \frac{1}{0,2 + 0,4j + Z}\right)^{-1}$$

$Z_p = 832,05\angle 33,69°$

$Z = 100\angle 30°$

$Z_2 = 89,58\angle 30,52°$

$Z_{uk} = 0,4j + 0,3 + Z_2$ ⇐

$Z_{uk} = 90\angle 30,64°$

$$I_2 = I \cdot \left(\frac{832,05\angle 33,69°}{832,05\angle 33,69° + 0,2 + 0,4j + 100\angle 30°}\right)$$

nuti Z

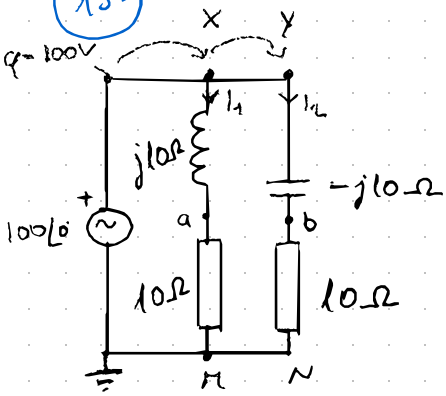
$$* \quad I_2 = I \cdot \frac{\text{Ol. koji nas ne zanima}}{\text{Suma grana}}$$

I ukupna

$$I = \frac{I_2}{Z_{nuti}} = 11,2\angle -30,38°$$

$$U_1 = I \cdot Z_{uk} = 1008,38\angle 0,258° = \boxed{1008,37 + 4,54j}$$

15.



$U_{ab}=?$

$$I_1=\frac{U}{j10+10}=\frac{100\angle 0^\circ}{10+10j}$$

$$I_1=5\sqrt{2}\angle -45^\circ$$

$$I_2=\frac{U}{-10j+10}=\frac{100\angle 0^\circ}{10-10j}=5\sqrt{2}\angle 45^\circ$$

$\varphi_A=?$

1° u točki x je $\varphi=100$, to znači da je u φ_A => 100 - struja x taj element

2° u točki M je 0, onda je 10 x struja $=\varphi_A$

$$\Rightarrow \varphi_A = I_1\cdot 10 = 100 - I_1\cdot 10j$$

$$\Rightarrow \varphi_B = I_2\cdot 10 = 100 - I_2\cdot(-10j)$$

$$U_{AB}=\varphi_A-\varphi_B=100\angle -90^\circ$$