Temă seminar 12

(1) $e(t) = 24 + 24\sqrt{2}\sin(\omega t + \frac{\pi}{2}) + 4\sqrt{2}\sin(2\omega t)$ [V]

$R_1 = 12\,\Omega$

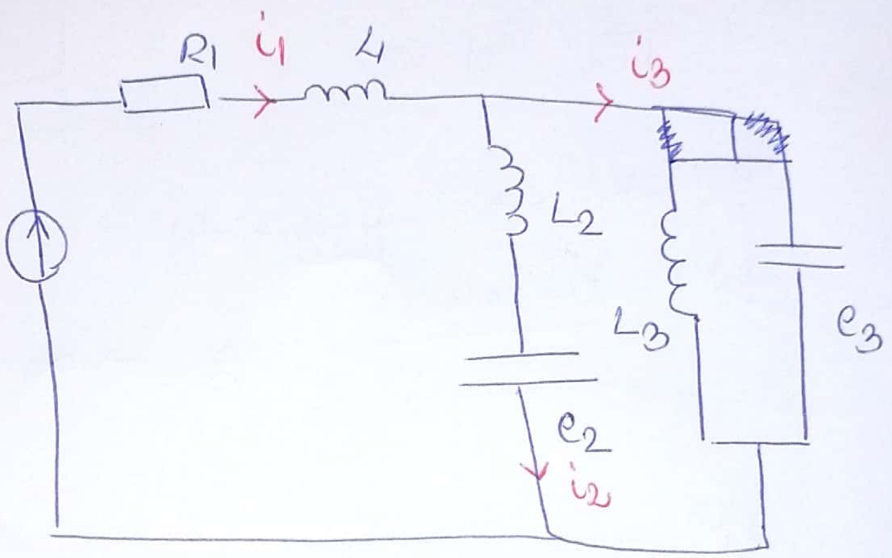
$\omega L_1 = 4\,\Omega$

$\omega L_2 = 4\,\Omega$

$\frac{1}{\omega C_2} = 8\,\Omega$

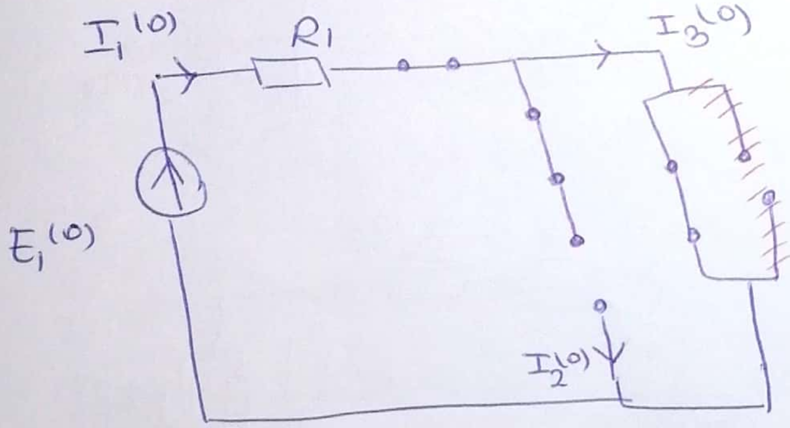
$\omega L_3 = 6\,\Omega$

$\frac{1}{\omega C_3} = 6\,\Omega$



$e_1(t) = E_1^{(0)} + e_1^{(1)}(t) + e_1^{(2)}(t)$

$E_1^{(0)} = 24$ V → în curent continuu



deoarece avem un scurt circuit

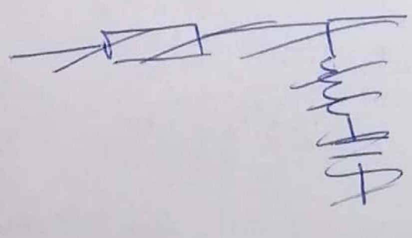
$I_2^{(0)} = 0$ A

$I_3^{(0)} = I_1^{(0)} = 2$A

$I_1^{(0)} = \frac{E_1^{(0)}}{R} = \frac{24}{12} = 2$A

$P = E_1^{(0)} \cdot I_1^{(0)}$
$= 24 \cdot 2 = 48$ W

Armonica de ordin 1 → armonica fundamentală



$e_1^{(1)} = 24\sqrt{2}\sin(\omega t + \frac{\pi}{2})$

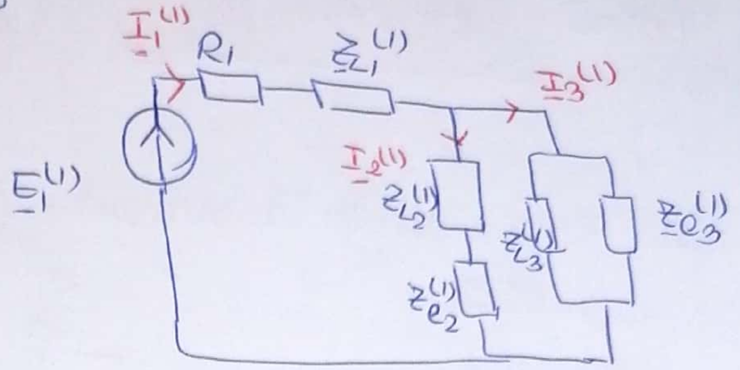
$E_1^{(1)} = \frac{24\sqrt{2}}{2} e^{j\frac{\pi}{2}} = 24(\underbrace{\cos\frac{\pi}{2}}_{0} + j\underbrace{\sin\frac{\pi}{2}}_{1})$
$= 24j$ [V]

$\underline{Z}_{L_1}^{(1)} = \underline{Z}_{L_2}^{(1)} = j\omega L_1 = 4j$ [Ω]

$\underline{Z}_{L_3}^{(1)} = j\omega L_3 = 8j$ [Ω]

$\underline{Z}_{C_2}^{(1)} = \dfrac{-j}{\omega C_2} = -8j$ [Ω]

$\underline{Z}_{C_3}^{(1)} = \dfrac{-j}{\omega C_3} = -8j$ [Ω]

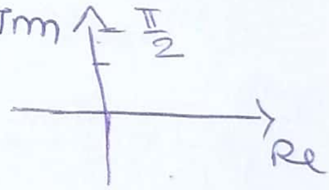


$\underline{Z}_2^{(1)} = \underline{Z}_{L_2}^{(1)} + \underline{Z}_{C_2}^{(1)} = 4j - 8j = -4j$

$\underline{Z}_3^{(1)} = \dfrac{\underline{Z}_{L_3}^{(1)} \cdot \underline{Z}_{C_3}^{(1)}}{\underline{Z}_{C_3}^{(1)} + \underline{Z}_{L_3}^{(1)}} = -\dfrac{36}{0} \rightarrow \infty \Rightarrow \underline{I}_3^{(1)} = 0$ [A] $\rightarrow$ $i_3^{(1)}(t) = 0$

$\underline{I}_1^{(1)} = \underline{I}_2^{(1)} = \dfrac{\underline{E}_1^{(1)}}{R_1 + \underline{Z}_4^{(1)} + \underline{Z}_2^{(1)}} = \dfrac{24j}{12 + \cancel{4j - 4j}} = 2j$ [A]

$i_1^{(1)}(t) = i_2^{(1)}(t) = 2\sqrt{2}\sin\left(\omega t + \frac{\pi}{2}\right)$



La armonica a doua:

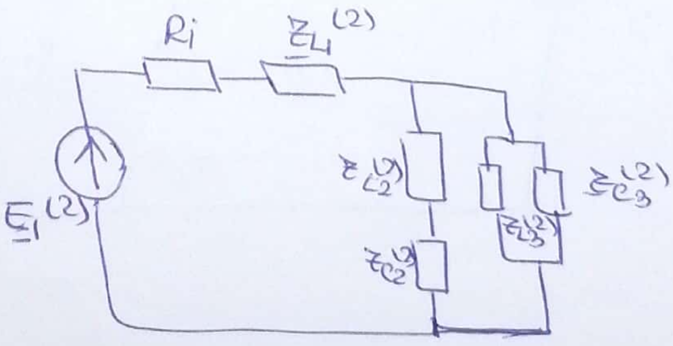
$e_1^{(2)} = 4\sqrt{2}(2\omega t)$

$\underline{Z}_{L_1}^{(2)} = \underline{Z}_{L_2}^{(2)} = 2j\omega L_1 = 8j$

$\underline{Z}_{L_3}^{(2)} = 2j\omega L_3 = 12j$

$\underline{Z}_{C_2}^{(2)} = \dfrac{-j}{2\omega C_2} = -4j$

$\underline{Z}_{C_3}^{(1)} = \dfrac{-j}{2\omega C_3} = -3j$

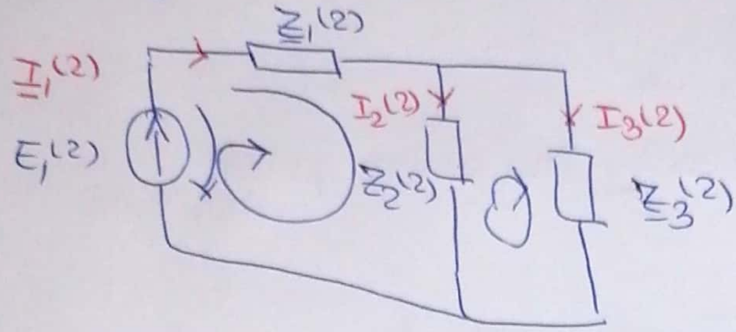


$\underline{E}_1^{(2)} = 4(\cos 0 + j\sin 0) = 4$ [V]

$\underline{Z}_2^{(2)} = \underline{Z}_{L_2}^{(2)} + \underline{Z}_{C_2}^{(2)} = 8j - 4j = 4j$

$\underline{Z}_3^{(2)} = \dfrac{\underline{Z}_{C_3}^{(2)} \cdot \underline{Z}_{L_3}^{(2)}}{\underline{Z}_{C_3}^{(2)} + \underline{Z}_{L_3}^{(2)}} = \dfrac{12j \cdot (-3)j}{9j} = -4j$

$Z_1^{(2)} = 12+8j$



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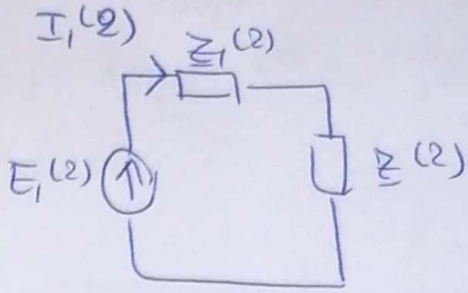


$\boxed{T1K}$ $I_1^{(2)} = I_2^{(2)} + I_3^{(2)} \Rightarrow$

$I_2^{(2)} = -I_3^{(2)}$

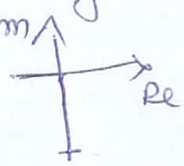
$Z^{(2)} = \frac{-4j \cdot 4j}{0} = \infty \to I_1^{(2)} = 0$ A

$\boxed{T2K}$ ~~$I_2^{(2)} Z_2^{(2)} = -I_3^{(2)} \cdot Z_3^{(2)} \Rightarrow -4j\, I_3^{(2)} = +I_3^{(2)} 4j$~~ $\Rightarrow$

$\underbrace{I_1^{(2)} \cdot Z_1^{(2)}}_{0} + I_2^{(2)} \cdot Z_2^{(2)} = +E_1^{(2)}$

$\cancel{4}j\, I_2^{(2)} = +\cancel{4} \Rightarrow I_2^{(2)} = \frac{+1}{j} = -j \Rightarrow I_2^{(2)} = -j$ [A]

$I_3^{(2)} = +j$ [A]



$i_2^{(2)}(t) = \sqrt{2} \sin(2\omega t - \frac{\pi}{2})$ [A]

$i_3^{(2)}(t) = \sqrt{2} \sin(2\omega t + \frac{\pi}{2})$ [A]

$i_1(t) = 2 + 2\sqrt{2} \sin(\omega t + \frac{\pi}{2})$

$i_2(t) = 2\sqrt{2} \sin(\omega t + \frac{\pi}{2}) + \sqrt{2} \sin(2\omega t - \frac{\pi}{2})$

$i_3(t) = 2 + \sqrt{2} \sin(2\omega t + \frac{\pi}{2})$

2) $S^{(1)} = P^{(1)} + jQ^{(1)}$

$S^{(1)} = E_1^{(1)} \cdot I_1^{*(1)} = 24j(-2j) = -48j^2 = +48$ VA

$P^{(1)} = 48$ W

$Q^{(1)} = 0$ VAR

$S^{(2)} = P^{(2)} + jQ^{(2)}$

$S^{(2)} = \underline{E}_1^{(2)} \cdot \underline{I}_1^{(2)*} = 4 \cdot 0 = 0 \text{ VA}$

Pe armonica 2, nu avem putere debitată

$\cancel{I_1 ef = \sqrt{4+4 \cdot 2 + 0} = \sqrt{4+8} = \sqrt{12} = 2\sqrt{3} \text{ A}}$

$\cancel{E_1 ef = \sqrt{24^2 + 24^2 \cdot 2 + 4^2} = \sqrt{1168}} = \sqrt{1744}$

$\cancel{S = E_1 ef \cdot I_1 ef = 2\sqrt{3} \cdot \sqrt{1168}} = \sqrt{1744}$

$I_1 ef = \sqrt{4 + 4} = \sqrt{8}$

$E_1 ef = \sqrt{24^2 + 24^2 + 16} = \sqrt{1168}$

$S = E_1 ef \cdot I_1 ef = \sqrt{8 \cdot 1168} = 96{,}6 \text{ VA}$

$P = E^{(0)} \cdot I_1^{(0)} + E^{(1)} \cdot I_1^{(1)} \cos\varphi^{(1)} + E^{(2)} I_1^{(2)} \cos\varphi^{(2)}$

$P = 24 \cdot 2 + 24 \cdot 2 \cos\underbrace{\left(\frac{\pi}{2} - \frac{\pi}{2}\right)}_{0} + 0 = 48 + 48 = 96 \text{ W}$

$Q = E^{(1)} \cdot I_1^{(1)} \sin\varphi + E^{(2)} \cdot I_2^{(2)} \sin\varphi$

$Q = 24 \cdot 2 \sin\left(\frac{\pi}{2} - \frac{\pi}{2}\right) + 0 = 0 \text{ VAR}$

$D = \sqrt{S^2 - P^2 - Q^2} = \sqrt{\cancel{887,808}\ 128} = 11{,}31 \text{ VAd}$