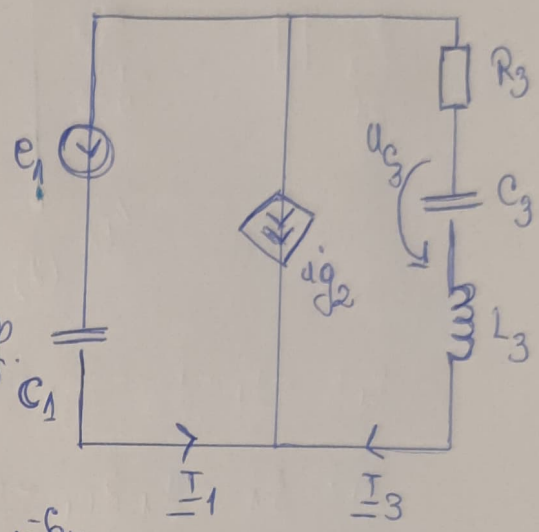
# TEMĂ SEMINAR 8

① $e_1(t) = 4\sin(10^6 t + \frac{3\pi}{4})$ [V]

$ig_2(t) = u_{C_3}(t)$ [A]

$C_1 = 0{,}5\,\mu F$

$R_3 = 1\,\Omega$, $C_3 = 1\,\mu F$, $L_3 = 2\,\mu H$




- Să se afle necc. aplicând Kirchhoff.

$\omega = 10^6$ rad/s

$C_1 = 0{,}5 \cdot 10^{-6}$ F, $C_3 = 10^{-6}$ F, $L_3 = 2 \cdot 10^{-6}$ H

$\underline{E}_1 = 2\sqrt{2}\, e^{j\frac{3\pi}{4}} = 2\sqrt{2} \cdot (\cos\frac{3\pi}{4} + j\sin\frac{3\pi}{4}) = -2 + 2j$

$\cos\frac{3\pi}{4} = \cos(\frac{\pi}{4} + \frac{\pi}{2}) = -\sin\frac{\pi}{4} = -\frac{1}{\sqrt{2}}$

$\sin\frac{3\pi}{4} = \sin(\frac{\pi}{4} + \frac{\pi}{2}) = \cos\frac{\pi}{4} = \frac{1}{\sqrt{2}}$

$\boxed{\underline{E}_1 = -2+2j}$

$\underline{I}_{g2} = \underline{U}_{C_3} = \underline{I}_3 \underline{Z}_{C_3} \Rightarrow \boxed{\underline{I}_{g_2} = -j\underline{I}_3}$

$\underline{Z}_{C_3} = \frac{-j}{\omega C_3} = -j$, $\underline{Z}_{L_3} = j\omega L_3 = 2j$, $\underline{Z}_{C_1} = \frac{-j}{\omega C_1} = -2j$

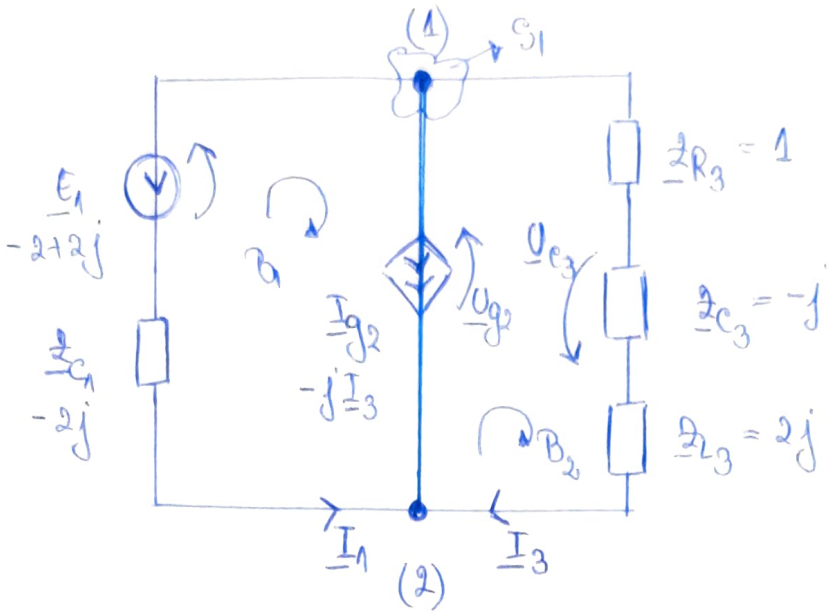
Din pagina următoare: $\underline{I}_1 = -2-2j$ ; $\underline{I}_3 = 2j$ ; $\underline{U}_{g_2} = 2-2j$.

$\varphi = \operatorname{arctg}\frac{-2}{-2} = \frac{\pi}{4}$, $|\underline{I}_1| = \sqrt{4+4} = 2\sqrt{2}$ : $i_1(t) = 4\sin(10^6 t + \frac{\pi}{4})$

$\varphi = \operatorname{arctg}\frac{2}{0} = \frac{\pi}{2}$, $|\underline{I}_3| = 2$ : $i_3(t) = 2\sqrt{2}\sin(10^6 t + \frac{\pi}{2})$

$\varphi = \operatorname{arctg}\frac{-2}{2} = -\frac{\pi}{4}$, $|\underline{U}_{g_2}| = 2\sqrt{2}$ : $u_{g_2}(t) = 4\sin(10^6 t - \frac{\pi}{4})$

$\omega = 10^6$ rad/s




$n = 2, \quad l = 3$

$\begin{cases} n - R + 1 = 2 & (T2K) \\ n - 1 = 1 & (T1K) \end{cases}$

$S_1: \quad -\underline{I}_1 - \underline{I}_3 - \underline{I}_{g_2} = 0 \Rightarrow \underline{I}_1 = -\underline{I}_3 + j\underline{I}_3 \Rightarrow \boxed{\underline{I}_1 = (j-1)\underline{I}_3}$

$B_1: \quad \underline{E}_1 - \underline{I}_1 \underline{Z}_{C_1} - \underline{U}_{g_2} = 0$

$B_2: \quad \underline{U}_{g_2} + \underline{I}_3 (\underline{Z}_{R_3} + \underline{Z}_{L_3}) + \underline{U}_{C_3} = 0 \Rightarrow$

$\oplus \Rightarrow \quad \underline{E}_1 - \underline{I}_1 \underline{Z}_{C_1} + \underline{I}_3 (\underline{Z}_{R_3} + \underline{Z}_{L_3}) - j\underline{I}_3 = 0 \Rightarrow$

$\Rightarrow \underline{E}_1 - (j-1)\underline{I}_3 \cdot \underline{Z}_{C_1} + \underline{I}_3 (\underline{Z}_{R_3} + \underline{Z}_{L_3}) - j\underline{I}_3 = 0 \Rightarrow$

$\Rightarrow -2+2j + 2j(j-1)\cdot \underline{I}_3 + \underline{I}_3 (1+2j) - j\underline{I}_3 = 0 \Rightarrow$

$\Rightarrow \underline{I}_3 (-2 - \cancel{2j} + 1 + \cancel{2j} - j) = 2 - 2j \Rightarrow \underline{I}_3 = \frac{2-2j}{-1-j} \Rightarrow$

$\Rightarrow \underline{I}_3 = \frac{2(1-j)(-1+j)}{1+1} \Rightarrow \underline{I}_3 = -(1-j)^2 = +2j$

$\boxed{\underline{I}_3 = 2j} \qquad \underline{I}_1 = 2j(j-1) = -2-2j \Rightarrow \boxed{\underline{I}_1 = -2-2j}$

$\underline{U}_{g_2} = \underline{E}_1 - \underline{I}_1 \underline{Z}_{C_1} \Rightarrow \underline{U}_{g_2} = -2+2j + (2+2j)\cdot(-2j) =$

$= -2+2j-4j+4 = 2-2j \Rightarrow \boxed{\underline{U}_{g_2} = 2-2j}$

(2.) $e_1(t) = 8\sqrt{2}\sin(\omega t)$ [V]

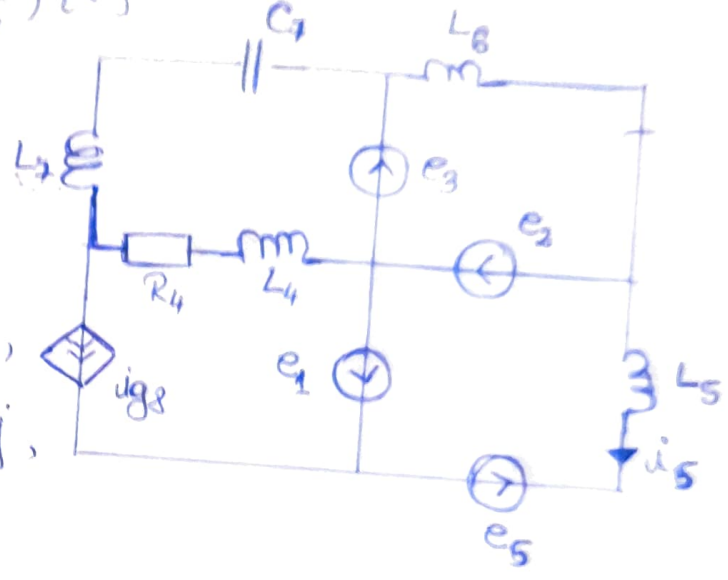
$e_2(t) = 8\sqrt{2}\sin(\omega t + \frac{\pi}{2})$ [V]

$e_3(t) = 16\sqrt{2}\sin(\omega t - \frac{\pi}{2})$ [V]

$e_5(t) = 8\sqrt{2}\sin(\omega t + \frac{3\pi}{2})$ [V]

$ig_8(t) = i_5(t)$ [A]

$R_4$ 1 Ω, $\omega L_4$ 1 Ω, $\omega L_5$ 2 Ω, $\omega L_6$ 2 Ω, $\omega L_7$ 4 Ω, $\frac{1}{\omega C_7} = 2$ Ω




$\underline{Z}_{R_4} = 1$, $\underline{Z}_{L_4} = j\omega L_4 = j$,

$\underline{Z}_{L_5} = j\omega L_5 = 2j$, $\underline{Z}_{L_7} = j\omega L_7 = 4j$,

$\underline{Z}_{L_6} = j\omega L_6 = 2j$, $\underline{Z}_{C_7} = \frac{-j}{\omega C_7} = -2j$,

$\underline{E}_1 = 8\,e^{j\cdot 0} = 8$

$\underline{E}_2 = 8\,e^{j\frac{\pi}{2}} = 8\left(\cos\frac{\pi}{2} + j\cdot\sin\frac{\pi}{2}\right) = 8j$

$\underline{E}_3 = 16\cdot e^{-j\frac{\pi}{2}} = -16j$

$\underline{E}_5 = 8\cdot e^{j\frac{3\pi}{2}} = 8\left(\cos\frac{3\pi}{2} + j\cdot\sin\frac{3\pi}{2}\right) = -8j$

$\underline{I}_{g8} = \underline{I}_5$

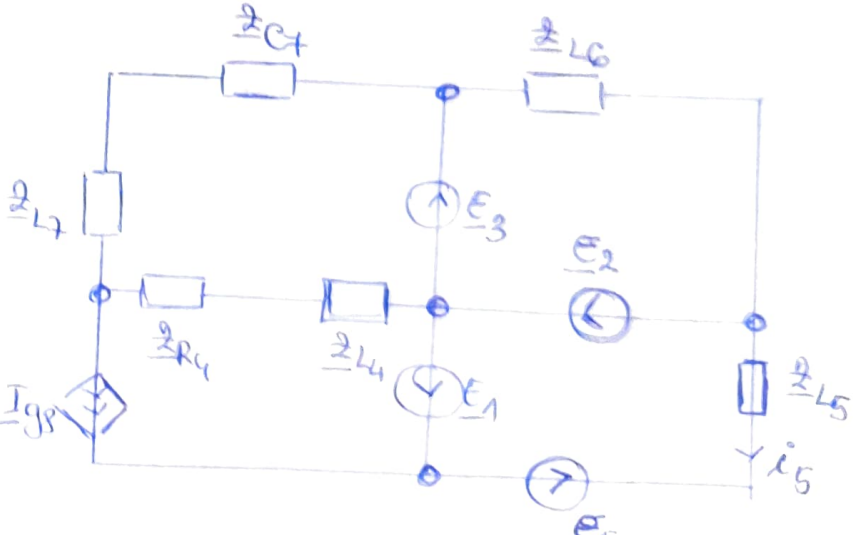
b) Metodă optimă: MNP

a) Kirchhoff:

$n - 1 = 5 - 1 = 4$ ec (TAK)

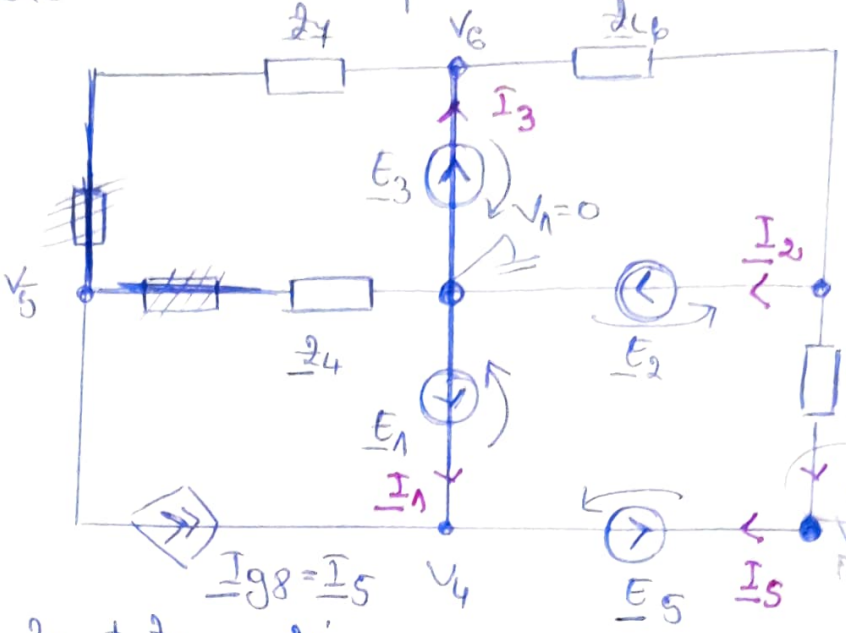
$l - n + 1 = 8 - 5 + 1 = 4$ ec

$n = 5$, $l = 8$ (T2K)




=> circuitul rezolvat cu Kirchhoff ar avea 8 ecuații.

d) Cale nee cure aplicând MNP




$I_5$ curent de comandă = 0

$$\begin{cases} \underline{Z}_7 = \underline{Z}_{L_7} + \underline{Z}_{C_7} = 2j \\ \underline{Z}_4 = \underline{Z}_{R_4} + \underline{Z}_{L_4} = 1+j \end{cases}$$

Necunoscute $V_2, V_3, V_4, V_5, V_6$

$I_2, I_1, I_5, I_3$

$$\begin{cases} \underline{E}_2 = \underline{V}_4 - \underline{V}_2 \Rightarrow \underline{V}_2 = -\underline{E}_2 \Rightarrow \boxed{\underline{V}_2 = -8j} \\ \underline{E}_1 = \underline{V}_4 - \underline{V}_1 \Rightarrow \underline{V}_4 = \underline{E}_1 \Rightarrow \boxed{\underline{V}_4 = 8} \\ \underline{E}_5 = \underline{V}_3 - \underline{V}_4 \Rightarrow \underline{V}_3 = \underline{E}_5 + \underline{V}_4 \Rightarrow \boxed{\underline{V}_3 = -8j+8} \end{cases}$$

$\underline{E}_3 = \underline{V}_6 - \underline{V}_1 \Rightarrow \underline{V}_6 = \underline{E}_3 \Rightarrow \boxed{\underline{V}_6 = -16j}$

$$\underline{V}_6\left(\frac{1}{\underline{Z}_7} + \frac{1}{\underline{Z}_{L_6}}\right) - \frac{\underline{V}_5}{\underline{Z}_7} - \frac{\underline{V}_2}{\underline{Z}_{L_6}} = \underline{I}_3$$

$$\underline{V}_5\left(\frac{1}{\underline{Z}_7} + \frac{1}{\underline{Z}_4}\right) - \frac{\underline{V}_6}{\underline{Z}_7} = -\underline{I}_{g8} = -\underline{I}_5$$

$$\underline{V}_3 \cdot \frac{1}{\underline{Z}_{L_5}} - \underline{V}_2 \cdot \frac{1}{\underline{Z}_{L_5}} = -\underline{I}_5 \Rightarrow \underline{I}_5 = \frac{\underline{V}_2 - \underline{V}_3}{\underline{Z}_{L_5}} = \frac{-8j+8j-8}{2j}$$

$$= \frac{-4}{j} = \frac{-4j}{-1} = 4j \Rightarrow \boxed{\underline{I}_5 = 4j}$$

$$\underline{V}_2\left(\frac{1}{\underline{Z}_{L6}}+\frac{1}{\underline{Z}_{L5}}\right)-\frac{\underline{V}_3}{\underline{Z}_{L5}}-\frac{\underline{V}_6}{\underline{Z}_{L6}}=-\underline{I}_2$$

$$\underline{I}_1+2\underline{I}_5=0 \Rightarrow \underline{I}_1=-2\underline{I}_5 \Rightarrow \boxed{\underline{I}_1=-8j}$$

$$-16j\left(\frac{1}{2j}+\frac{1}{2j}\right)-\frac{\underline{V}_5}{2j}-\frac{-8j}{2j}=\underline{I}_3 \Rightarrow$$

$$\Rightarrow -16-\frac{\underline{V}_5}{2j}+4=\underline{I}_3 \Rightarrow \underline{V}_5=2j(-12-\underline{I}_3)=-24j-2j\underline{I}_3$$

$$\boxed{\underline{V}_5=-24j-2j\,\underline{I}_3}$$

$$\underline{V}_5\left(\frac{1}{2j}+\frac{1}{1+j}\right)+\frac{16j}{2j}=-4j \Rightarrow \underline{V}_5\cdot\frac{1+j+2j}{2j-2}=-12j \Rightarrow$$

$$\Rightarrow \underline{V}_5\cdot\frac{(3j+1)(2j+2)}{-4-4}=-12j \Rightarrow \underline{V}_5\cdot\frac{-6+8j+2}{-8}=-12j \Rightarrow$$

$$\Rightarrow \underline{V}_5\cdot\frac{-4+2j}{-2}=-12j \Rightarrow \underline{V}_5=\frac{24j}{2j-1}=\frac{24j(2j-1)}{-4-1} \Rightarrow$$

$$\Rightarrow \boxed{\underline{V}_5=\frac{-48-24j}{5}}$$

$$\underline{I}_3=\frac{\underline{V}_5+24j}{-2j}=\frac{-48-24j+120j}{-10j}=\frac{24+12j-60j}{5}=$$

$$=\frac{24-48j}{5} \Rightarrow \boxed{\underline{I}_3=\frac{-48j+24}{5}}$$

$$\underline{I}_2=\frac{+8j-8}{2j}+\frac{-16j}{2j}+8j\left(\frac{1}{2j}+\frac{1}{2j}\right)=4+4j-8+8=4+4j$$

$$\boxed{\underline{I}_2=4+4j}$$

③ $e_1(t) = 8\sqrt{2}\,\sin\left(2t - \frac{\pi}{2}\right)$ [V]

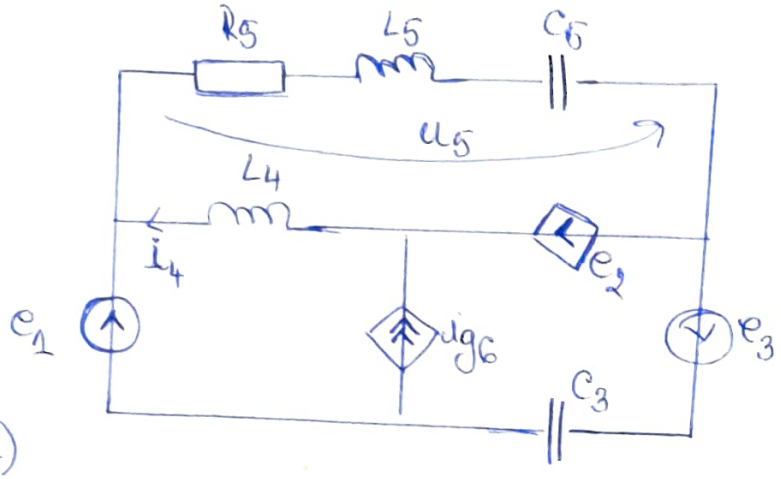
$e_2(t) = 2\,i_4(t)$ [V]

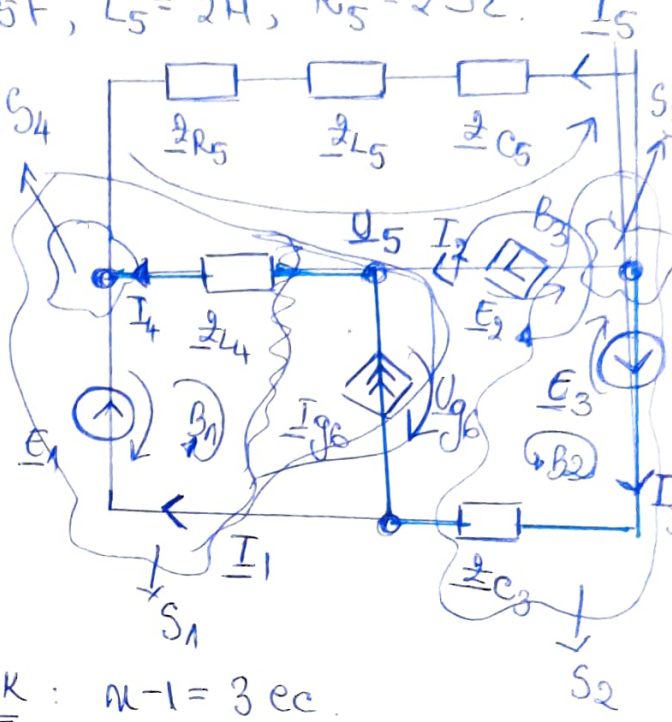
$e_3(t) = 4\sqrt{2}\,\sin\left(2t + \frac{\pi}{2}\right)$ [V]

$i_{g6}(t) = 0{,}5\,u_5(t)$ [A]

$C_3 = 0{,}5$ F ; $L_4 = 1$ H, $C_5 = 0{,}25$ F, $L_5 = 2$ H, $R_5 = 2\,\Omega$.

a)




$S_1$: $-\underline{I}_4 - \underline{I}_{g6} - \underline{I}_5 - \underline{I}_4 = 0$

$S_2$: $\underline{I}_3 + \underline{I}_2 + \underline{I}_5 = 0$

~~$S_3$: $\underline{I}_3 - \underline{I}_5 + \underline{I}_4$~~

$S_3$: $-\underline{I}_4 - \underline{I}_5 - \underline{I}_1 = 0$

TIK: $n - 1 = 3$ ec.

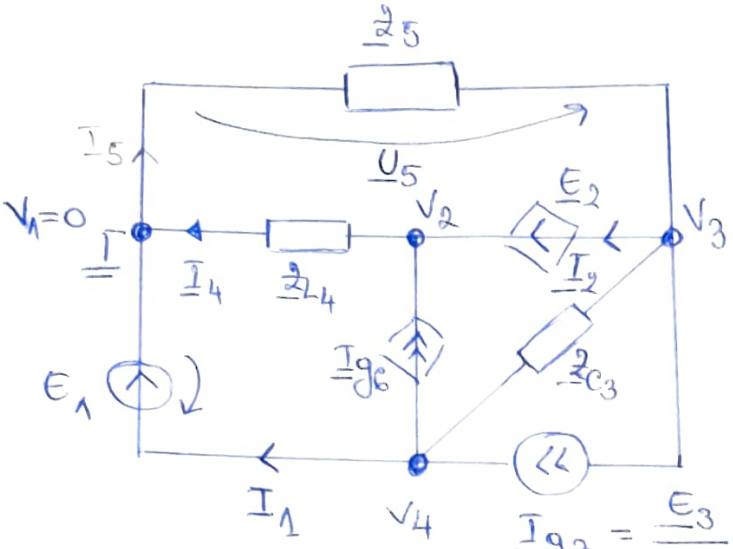
$B_1$: $-\underline{I}_4 \underline{Z}_{L4} + \underline{U}_{g6} - \underline{E}_1 = 0$

TIK: $l - n + 1 = 6 - 4 + 1 = 3$ ec.

$B_2$: $-\underline{E}_2 + \underline{E}_3 - \underline{I}_3 \underline{Z}_{C3} + \underline{U}_{g6} = 0$

$B_3$: $\underline{U}_5 + \underline{I}_4 \underline{Z}_{L4} - \underline{U}_{g6} - \underline{E}_3 + \underline{I}_3 \underline{Z}_{C3} = 0$.

b) Calculați mec aplicând MNP




$\underline{E}_1 = 8e^{-j\frac{\pi}{2}} = -8j$

$\underline{E}_2 = 2\underline{I}_4$

$\underline{E}_3 = 4e^{j\frac{\pi}{2}} = 4j$

$\underline{I}_{g6} = \frac{1}{2}\underline{U}_5$

$\underline{Z}_{C3} = \frac{-j}{\omega C_3} = \frac{-j}{1} = -j$

$\underline{Z}_{L4} = j\omega L_4 = 2j$ , $\underline{Z}_{R5} = 2$

$\underline{Z}_{C5} = -2j$ , $\underline{Z}_{L5} = 4j$

$\underline{I}_{g3} = \frac{4j}{-j} = -4$

$\omega = 2\ rad/s$

$$\begin{cases} \underline{E}_1 = V_1 - V_4 \Rightarrow V_4 = -\underline{E}_1 \Rightarrow \boxed{V_4 = 8j} \\ \underline{U}_5 = V_1 - V_3 \Rightarrow \boxed{V_3 = -\underline{U}_5} \\ \underline{I}_1 + \underline{I}_{g6} = \underline{I}_{g3} \end{cases}$$

Necunoscute: $\underline{V}_2, \underline{V}_3, \underline{V}_4, \underline{I}_2, \underline{I}_1, \underline{I}_4, \underline{U}_5$

Comenzi

$V_2 - V_1 = -\underline{I}_4 \underline{Z}_{L4} \Rightarrow$

$\Rightarrow \underline{I}_4 = -\frac{V_2}{2j} = \frac{j}{2} \cdot V_2$

$\boxed{\underline{I}_4 = \frac{j}{2} \cdot \underline{V}_2}$

$$\begin{cases} \underline{V}_2 \left( \frac{1}{\underline{Z}_{L4}} \right) = \underline{I}_2 + \underline{I}_{g6} - \underline{I}_4 \\ \underline{V}_3 \cdot \frac{1}{\underline{Z}_{C3}} - \frac{\underline{V}_4}{\underline{Z}_{C3}} = -\underline{I}_{g3} - \underline{I}_2 \\ \underline{V}_4 \cdot \frac{1}{\underline{Z}_{C3}} - \frac{\underline{V}_3}{\underline{Z}_{C3}} = -\underline{I}_{g6} + \underline{I}_{g3} - \underline{I}_1 \end{cases}$$

c) $\underline{I}_5 = \underline{I}_4 + \underline{I}_1$

$\underline{U}_{g6}, \underline{U}_{g3}$ : Kirchhoff - teorema 2.