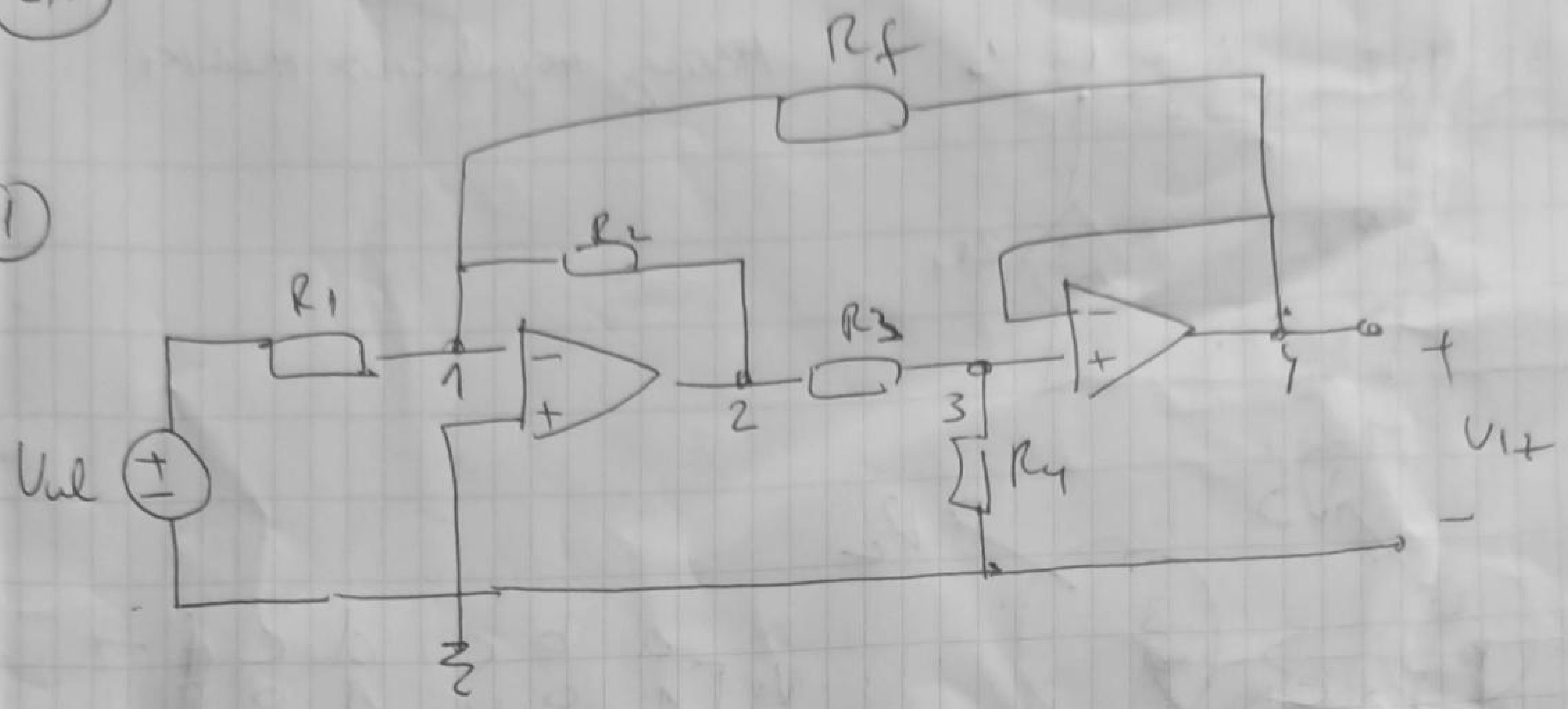
(G1)

(1)



$\underline{V_1 = 0}$

$$\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_f}\right)\cancel{V_1} - \frac{1}{R_2}V_2 - \frac{1}{R_f}V_4 = \frac{V_{ul}}{R_1} \qquad (1)$$

$\underline{V_3 = V_4}$

$$\left(\frac{1}{R_3}+\frac{1}{R_4}\right)V_3 - \frac{1}{R_3}V_2 = 0 \Rightarrow \frac{1}{R_3}V_2 = \left(\frac{1}{R_3}+\frac{1}{R_4}\right)V_4 \Rightarrow V_2 = \left(1+\frac{R_3}{R_4}\right)V_4 \qquad (2)$$

$$(2)\to(1) \Rightarrow -\frac{1}{R_2}\cdot\left(1+\frac{R_3}{R_4}\right)V_4 - \frac{1}{R_f}V_4 = \frac{V_{ul}}{R_1}$$

$$\left(-\frac{1}{R_2} - \frac{R_3}{R_2R_4} - \frac{1}{R_f}\right)V_4 = \frac{V_{ul}}{R_1}, \quad V_4 = \sigma_{17}$$

$$\Rightarrow \frac{\sigma_{17}}{\sigma_{ul}} = -\frac{1}{\frac{R_1}{R_2} + \frac{R_1R_3}{R_2R_4} + \frac{R_1}{R_f}}$$

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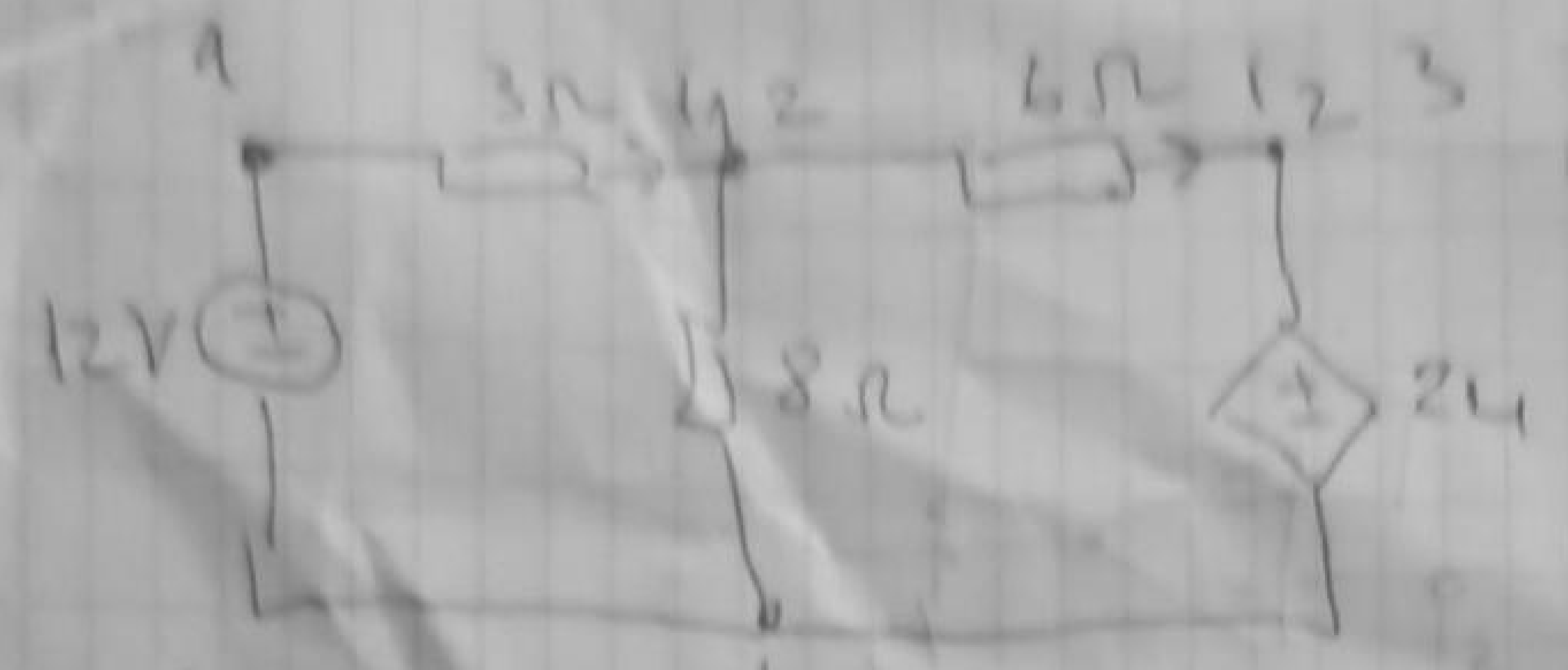
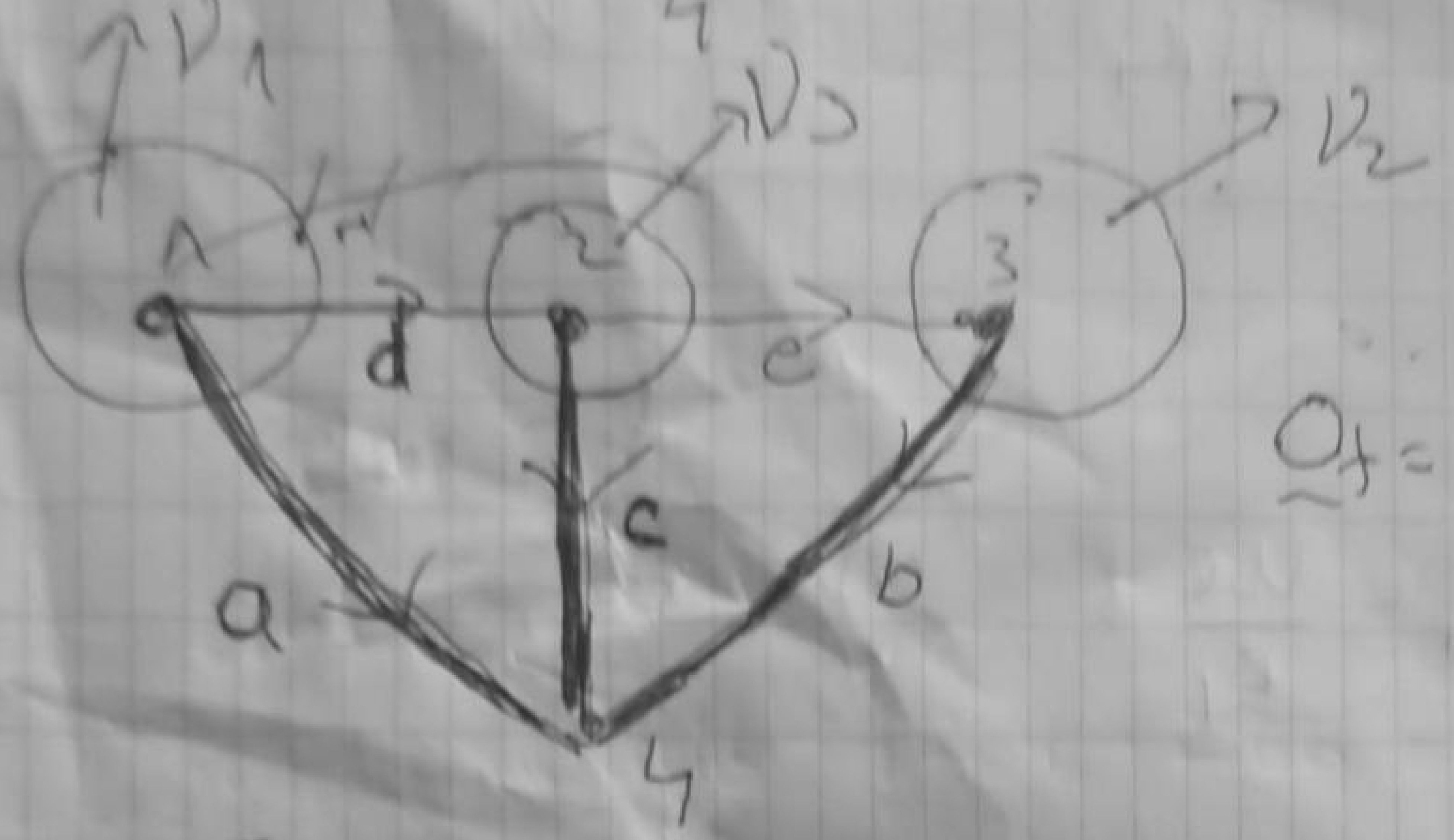
2

Metoda nezavisnih napona





$$\underset{\sim}{Q}_f = \begin{array}{c} \\ V_1 \\ V_2 \\ V_3 \end{array} \begin{array}{ccc|cc} a & b & c & d & e \\ 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & -1 \\ 0 & 0 & 1 & -1 & 1 \end{array}$$

$$\underset{\sim}{u} = \underset{\sim}{Q}_f^T \cdot u_T$$

$$\begin{bmatrix} u_a \\ u_b \\ u_c \\ u_d \\ u_e \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & -1 \\ 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} u_a \\ u_b \\ u_c \end{bmatrix} \Rightarrow \begin{aligned} u_d &= u_a - u_c \\ u_e &= -u_b + u_c \end{aligned}$$

$u_a = 12\ V$

$u_b = 2u = 2u_d$

$\Rightarrow u_d = 12 - u_c$

$u_e = -2u_d + u_c \Rightarrow u_e = -2(12 - u_c) + u_c = -24 + 3u_c$

$i_d = i_e + i_c \Rightarrow \frac{u_d}{3} = \frac{u_e}{6} + \frac{u_c}{8}$

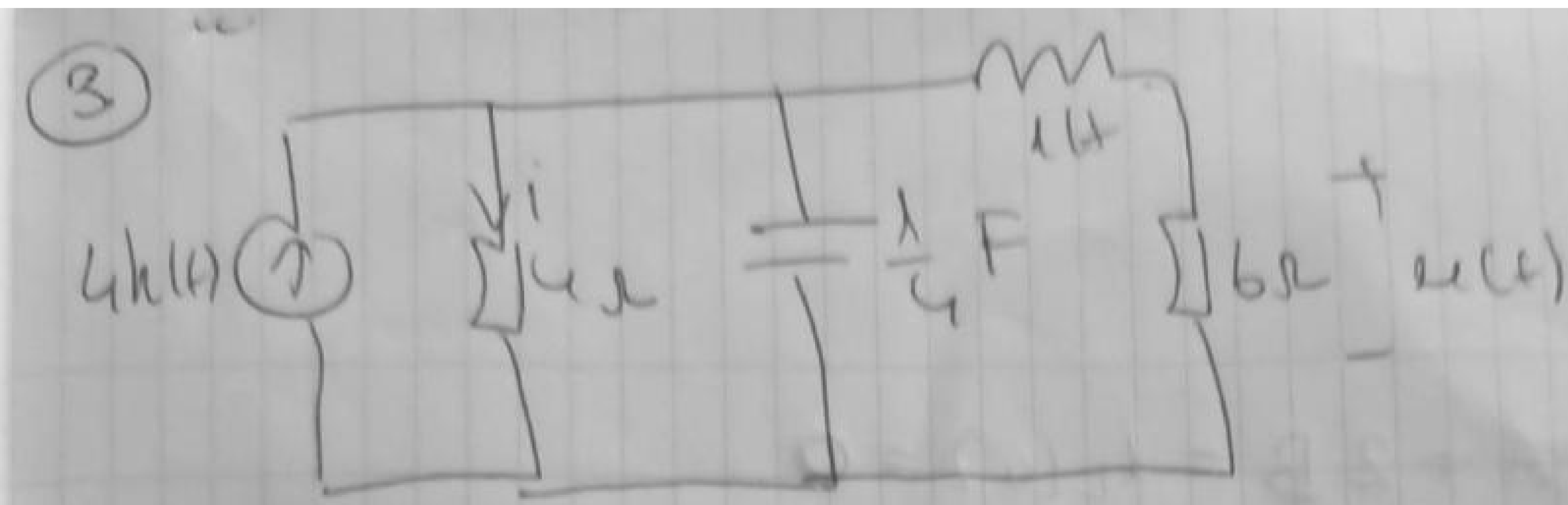
$\Rightarrow 4 - \frac{u_c}{3} = -\frac{\cancel{24}^{4}}{\cancel{6}} + \frac{u_c}{2} + \frac{u_c}{8}$

$8 = \frac{u_c}{3} + \frac{u_c}{2} + \frac{u_c}{8} \Rightarrow u_c = 8.34$

$u_d = 3{,}66 \Rightarrow i_1 = 1{,}22\ A$

$u_e = -24 + 3u_c = 1{,}02\ V \Rightarrow i_2 = 0.17\ A$

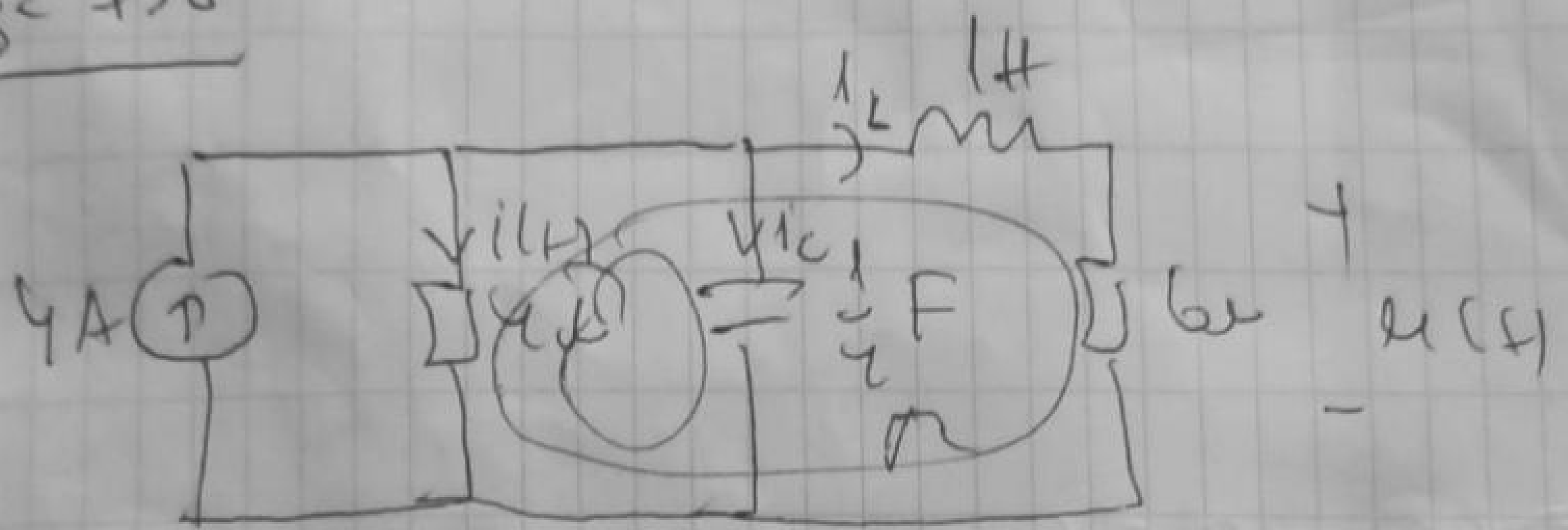
③



se $t<0$

$i_L(0^-) = 0\,A \qquad u_c(0^-) = 0V$

se $t>0$



$i(t) = ?$

$4 = i + i_c + i_L \quad (1)$

$u_c = 4i \Rightarrow i_c = C\dfrac{du_c}{dt} = 4C\dfrac{di}{dt} = \dfrac{di}{dt}$

$4 \cdot i = u_L + 6 \cdot i_L \Rightarrow 4i = L\dfrac{di_L}{dt} + 6 \cdot i_L \quad (*)$

$(1) \Rightarrow i_L = 4 - i - i_c$

$\rightarrow (*) \Rightarrow 4 \cdot i = L\dfrac{d}{dt}\left(4 - i - \dfrac{di}{dt}\right) + 6 \cdot \left(4 - i - \dfrac{di}{dt}\right)$

$\left(D^2 + 7D + 10\right)i = 24 \quad (**)$

$s^2 + 7s + 10 = 0$

$s_{1,2} = \dfrac{-7 \pm \sqrt{49-40}}{2} \Rightarrow s_1 = -5\,,\; s_2 = -2$

$\Rightarrow i_h(t) = Ae^{-5t} + Be^{-2t}$

$i_p = K \xrightarrow{(**)} 10K = 24 \Rightarrow K = 2{,}4$

$i = Ae^{-5t} + Be^{-2t} + 2.4$

$u_c(t) = 4i(t) \Rightarrow u_c(0^+) = 4A + 4B + 9.6 = u_c(0^-) = 0$

$4(A+B) = -9{,}6 \Rightarrow A+B = -2.4 \Rightarrow A = -2.4 - B \quad (***)$

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$i_L = 4 - i - \frac{di}{dt}$

$i_L(0^+) = 4 - A - B - 2.4 + 5A + 2B = i_L(0^+) = 0$

$-1.6 = 4A + B$

$A = 0.26 \quad B = -2.66$

$i(t) = 0.26e^{-5t} - 2.66e^{-2t} + 2.4 \quad , \quad t > 0$

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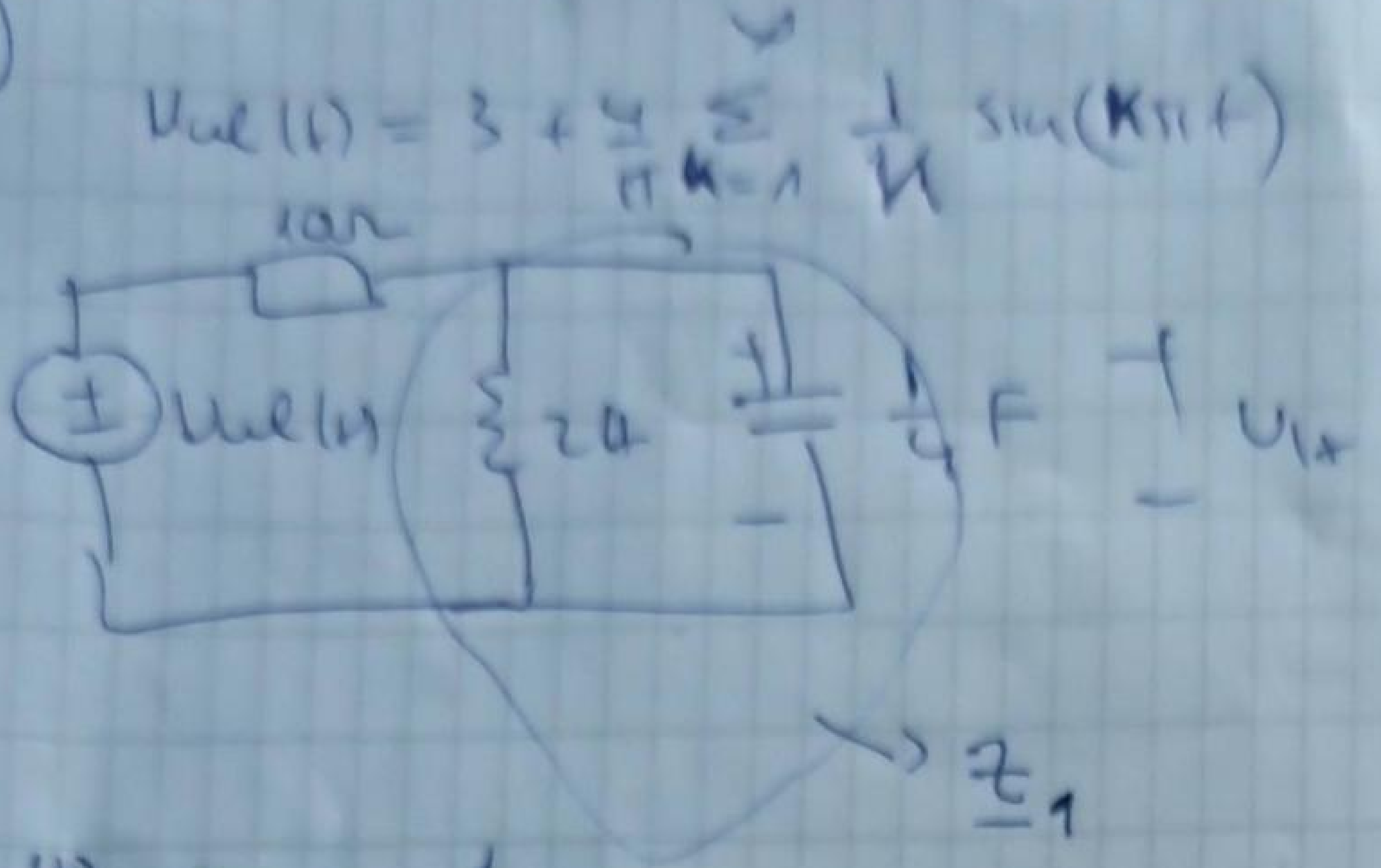
(4.)

$$u_{ul}(t) = 3 + \frac{4}{\pi}\sum_{k=1}^{\infty} \frac{1}{k}\sin(k\pi t)$$

$\underline{\omega = \pi}$



$\rightarrow \underline{Z}_1$

$$\underline{Z}_1^{(k)} = \frac{jk\omega L \cdot \frac{1}{jk\omega C}}{jk\omega L + \frac{1}{jk\omega C}} = \frac{jk\omega L}{1 - k^2\omega^2 LC}$$

$$U_{iz}^{(k)} = \frac{Z_1^{(k)}}{Z_1^{(k)} + R} U_{ul}^{(k)} \Rightarrow U_{iz}^{(k)} = \frac{\frac{jk\omega L}{1-k^2\omega^2 LC}}{\frac{jk\omega L}{1-k^2\omega^2 LC} + 10} U_{ul}^{(k)}$$

$$\Rightarrow U_{iz}^{(k)} = \frac{jk\omega L}{jk\omega L + 10 - 10k^2\omega^2 LC} U_{ul}^{(k)} = \frac{2jk\omega}{2jk\omega + 10 - 5k^2\omega^2} U_{ul}$$

$\underline{U_{iz}^{(0)} = 0V}$

za AC: $= \frac{2j\cancel{k\pi}}{2jk\pi + 10 - 5k^2\pi^2} \cdot \frac{4}{\cancel{k\pi}} = \frac{8j}{2jk\pi + 10 - 5k^2\pi^2}$

$$U_{iz}^{(k)} \; (k>0) = \frac{8}{\sqrt{(10-5k^2\pi^2)^2 + 4k^2\pi^2}} \angle \frac{\pi}{2} - \mathrm{arctg}\frac{2k\pi}{10-5k^2\pi^2}$$

$\rightarrow A_k$, θ_k

$$u_{iz}(t) = \sum_{k=1}^{\infty} A_k \sin(k\pi t + \theta_k)$$

b) $P_1 = \left(\frac{4}{\pi\sqrt{2}}\right)^2$ W

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