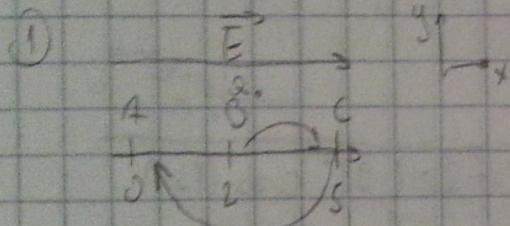


$$R_{\text{eq}} = \frac{1}{L} + \frac{1}{2} \left(\frac{1}{R_1} + \frac{1}{R_2} \right)$$

$$R_{\text{eq}} = \rho(R) \cdot L - \frac{V}{I}$$

$$I_A = I - \frac{3/3 R}{43/3 R} = \frac{6}{73} I$$

1. MASONNE INSTRUKCJE



I. $A_{B0} = -|u_{AB}| \cdot l_{AB}$

A diagram similar to the first one, but with a positive displacement u_{AB} indicated by a curved arrow labeled $+A$. The force vector E acts to the right at point A.

II. $A_{Ca} = +|u_{AC}| \cdot l_{AC}$

A diagram similar to the first one, but with a negative displacement u_{AC} indicated by a curved arrow labeled $-A$. The force vector E acts to the right at point A.

$$\alpha = -100 \text{ ps/As}$$

$$E = 100 \text{ MV/m}$$

$$U = Ed$$

$$U_{BC} = 10 \text{ MV/m} \cdot 0,23 \text{ m} =$$

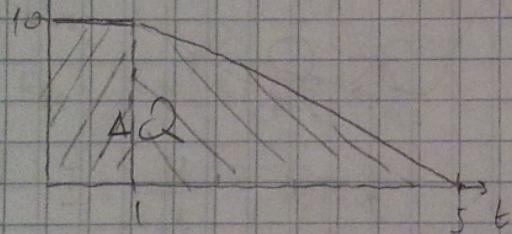
$$\text{I. } A_{BC} = -|U_{BC}| \cdot |Q_0| = -100 \text{ MV/m} \cdot 0,23 \text{ m} \cdot 100 \mu \text{As} = -30 \mu \text{A}$$

$$\text{II. } A_{CA} = +|U_{CA}| \cdot |Q_0| = +10 \text{ MV/m} \cdot 0,05 \text{ m} \cdot 100 \mu \text{As} = 50 \mu \text{A}$$

$$\text{III. } A_{AB} = A_{BC} + A_{CA} = -30 + 50 = +20 \mu \text{A}$$

(2)

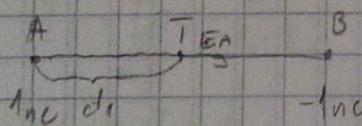
$$I_t$$



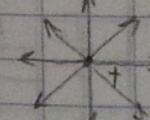
$$\bar{J} = \frac{dQ}{dt}$$

$$dQ = I \cdot dt = 1 \cdot 10 + 10 \cdot \frac{5}{2} = 30 \text{ As}$$

(1)



$$dl = 10 \text{ nm} \Rightarrow d_1 = 5 \text{ cm}$$

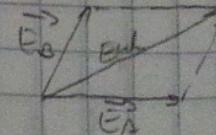


$$E_A = \frac{2\pi}{4\pi\epsilon_0 d_1^2} = \frac{lnc}{4\pi\epsilon_0 (0,05)^2} = 3595 \frac{\text{V}}{\text{m}}$$

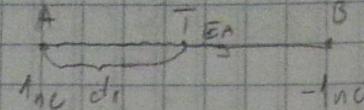
$$E_B = \frac{2\pi}{4\pi\epsilon_0 d_2^2} = \frac{lnc}{4\pi\epsilon_0 \cdot 0,05^2} = 3595 \frac{\text{V}}{\text{m}}$$

$$\vec{E}_{AB} = \vec{E}_A + \vec{E}_B = 3595 \cdot 2 = 7190 \text{ V/m}$$

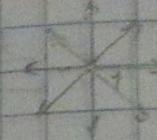
$$F_{31} \quad F_{21}$$



①

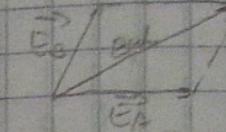


$$d = 10 \text{ nm} \Rightarrow d_1 = 5 \text{ cm}$$



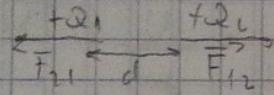
$$E_A = \frac{2 \cdot 1}{4\pi \epsilon_0 d_1^2} = \frac{1 \text{ nc}}{4\pi \epsilon_0 (0,05 \text{ m})^2} = 3595 \frac{\text{V}}{\text{m}}$$

$$E_B = \frac{2 \cdot 1}{4\pi \epsilon_0 d_2^2} = \frac{-1 \text{ nc}}{4\pi \epsilon_0 (0,05 \text{ m})^2} = 3595 \frac{\text{V}}{\text{m}}$$

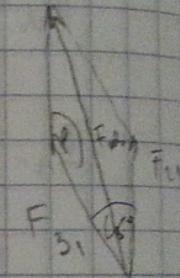
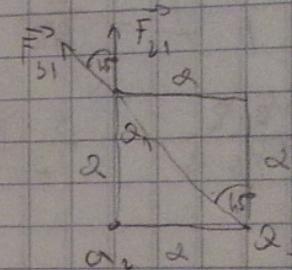
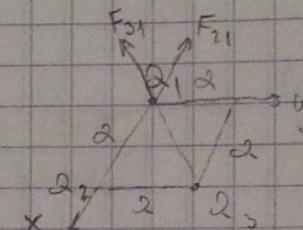


$$E_{\text{res}} = E_A + E_B = 3595 \cdot 2 = 7190 \frac{\text{V}}{\text{m}}$$

⑤



$$F = \frac{Q_1 Q_2}{4\pi \epsilon_0 \cdot d^2}$$



$$F_{21} = \frac{Q_2 Q_1}{4\pi \epsilon_0 \cdot d^2} = 8,98 \text{ nN}$$

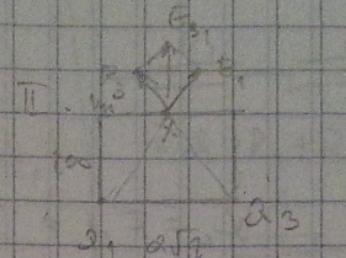
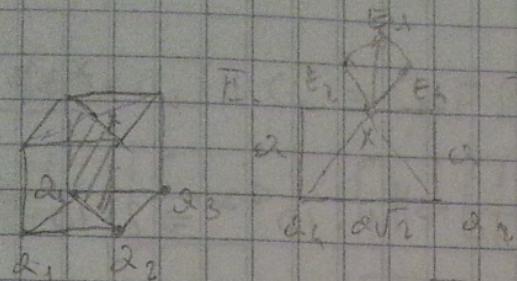
$$\alpha = 135^\circ$$

$$F_{31} = \frac{Q_3 Q_1}{4\pi \epsilon_0 \cdot (\sqrt{2}d)^2} = 8,98 \text{ nN}$$

$$c^2 = a^2 + b^2 - 2ab \cos(\varphi) \Rightarrow c = \sqrt{6,98^2 + 8,98^2 - 2 \cdot 8,98 \cdot 6,98 \cos(135^\circ)}$$

$$c = F_{\text{res}} = 16,59 \text{ nN}$$

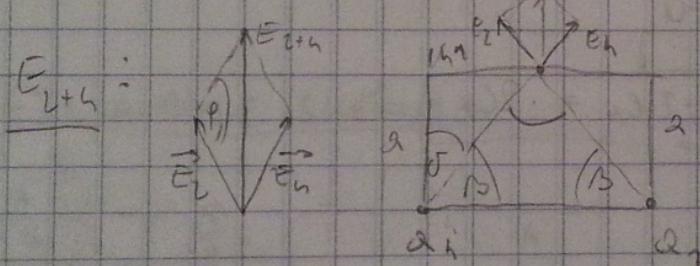
②



$$\vec{E}_{\text{sum}} = \vec{E}_2 + \vec{E}_3$$

$$z = \sqrt{\alpha^2 + \left(\frac{\alpha\sqrt{2}}{2}\right)^2} = \sqrt{200^2 + \left(\frac{200\sqrt{2}}{2}\right)^2} = 265 \text{ mm}$$

$$E_1 = E_2 = E_3 \Rightarrow E_h = \frac{Q}{4\pi\epsilon_0 z^2} = \frac{5 \mu C}{4\pi \cdot 8.86 \cdot (265)^2} = 746650 \text{ V/m}$$



$$\tan \delta = \frac{141}{200} \Rightarrow \delta = 35,18^\circ \quad \alpha = 90 - 35,18 = 54,7^\circ$$

$$\gamma = 180^\circ - 2\alpha = 70,52^\circ$$

$$\varphi = \frac{360 - 70}{2} = 109,47^\circ$$

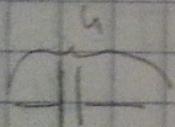
$$\underline{E_{\text{sum}}} = \sqrt{E_2^2 + E_3^2 + 2 E_2 E_3 \cos(109,47^\circ)} = 1222531,12 \text{ V/m}$$

$$\varphi = \frac{360 - 75}{2} = 109,47^\circ$$

$$E_{\text{tot}} = \sqrt{E_2^2 + E_L^2 + 2 E_2 E_L \cos(109,47^\circ)} = 1222,531,12 \text{ V/m}$$

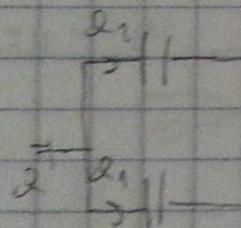
$$E_{\text{kin}} = 2 E_{\text{kin}} = 2,46 \frac{\text{J}}{\text{mm}}$$

KONDENSATORI



$$C [F] \quad Q [C] \quad U [V]$$

$$Q = U C \quad I = \frac{U}{R}$$



$$Q = Q_1 + Q_2$$

$$U_C = F \cdot d \Rightarrow \text{real Kondensatoren}$$

② $Q = 100 \text{ nC}$

$c = 1 \text{ mm}$

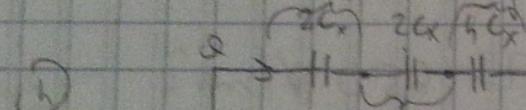
$F = 200 \text{ mN}$

$c = ?$

$W_c = F \cdot c = 200 \cdot 10^{-3} \cdot 1 \cdot 10^{-3} = 2 \cdot 10^{-4} \text{ J}$

XISPI

$$W_c = \frac{Q^2}{2c} \Rightarrow F \cdot c = \frac{Q^2}{2c} \Rightarrow c = \frac{Q}{2W_c} = \frac{(100 \cdot 10^{-9})^2}{2 \cdot 2 \cdot 10^{-4}} = 100 \text{ nm}$$



$$U = \frac{+1}{-}$$

$$U = U_x + 1 + U_y$$

$$0 = U_c = 1 \cdot 2c_x = 2c_x$$

$$U_x = \frac{Q}{2c_x} = \frac{2c_x}{2c_x} = 1 \text{ V}$$

$$U_y = \frac{Q}{4c_x} = \frac{2c_x}{4c_x} = 0,5 \text{ V}$$

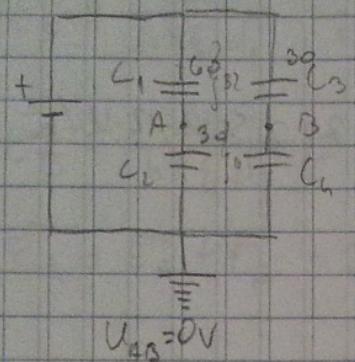
$$U_{\text{tot}} = 1 + U_x + U_y = 2,5 \text{ V}$$

$$(P_n = P_m - P_s)$$

$$U_y = U_{Cx} - U_{Ax} = 50V$$

$$U_{AB} = 1 + U_x + U_y = 25V$$

②



$$U_{AB} = \varphi_A - \varphi_B$$

$$\frac{U_{C1}}{U_{AB}} = \frac{C_2}{C_1} = \frac{30}{60} = \frac{1}{2} \Rightarrow U_{C2} = 2U_{C1}$$

$$U_{C2} = 2U_{C1} \Rightarrow U_4 + U_{C2} = U = 48V \Rightarrow \begin{cases} U_{C1} = 16 \\ U_{C2} = 32 \end{cases}$$

$$U_{AB} = 0V$$

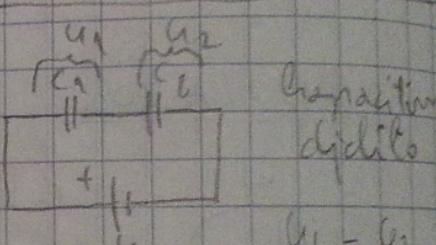
$$U_{AB} = \varphi_A - \varphi_B = 0$$

$$\varphi_B = 32V$$

$$C_2 = 30 \quad \{ 32V$$

$$C_1 = 60 \quad \{ 16V$$

$$U_{AB} = \varphi_A - \varphi_B = 16 - 32 = -16V$$

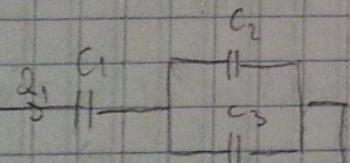


$$\frac{U_1}{U_2} = \frac{C_1}{C_2}$$

$$U_1 + U_2 = U$$

③

④



$$C_1 = 1nF$$

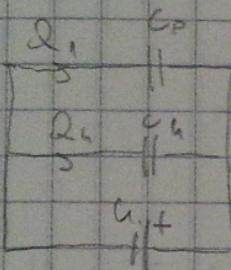
$$Q_4 = ?$$

$$C_2 = 2nF$$

$$C_3 = 3nF$$

$$C_4 = 4nF$$

$$= \frac{5+1}{5+1} = \left| \frac{5}{c} + n \right| \quad \left| n \right| = \left(\frac{1}{c} + 1 \right)^{-1}$$

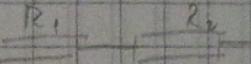


$$2 = 4 - 2$$

$$u = \frac{Q}{C}$$

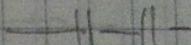
$$\frac{Q_1}{C_p} = \frac{Q_2}{C_n} \Rightarrow Q_2 = \frac{C_n}{C_p} \cdot Q_1 = 48 \text{ nAs}$$

५७८ -



$$R_{\text{sh}} = R_1 + R_2$$

Kōnū.



$$\text{Cuk} = \frac{4}{2}$$

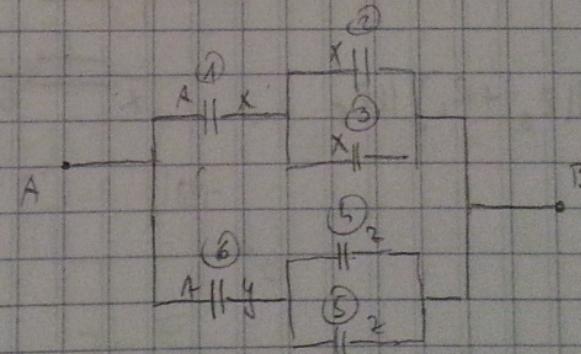
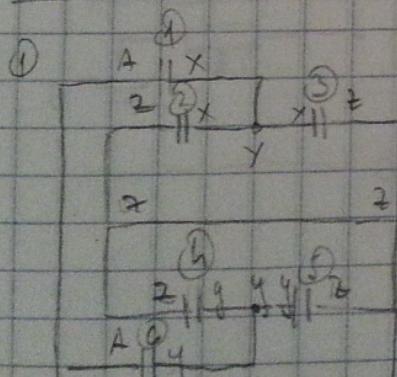
卷之三

$$R_{\text{ex}} = \frac{R}{\pi}$$

$$C_{\text{eff}} = C_1 + C_2$$

2021

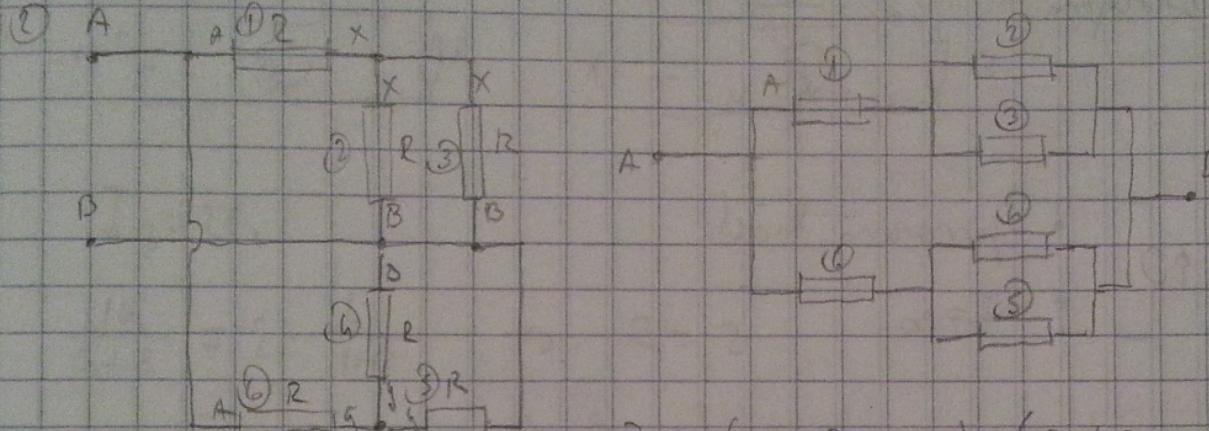
RASPETLJAVANJE SHEMA



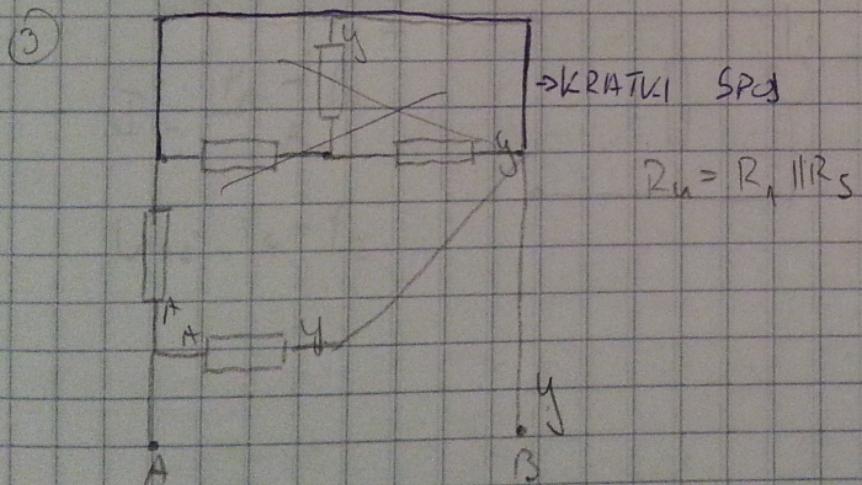
$$C_1 = (C_2 + C_3) \parallel C_1 + (C_4 + C_5) \parallel C_6$$

$$\begin{array}{|c|c|c|c|} \hline & 2 & 4 & 6 \\ \hline 1 & 0 & 1 & 0 \\ \hline 0 & 1 & 0 & 1 \\ \hline \end{array}$$

$$C_{\text{A}} = (C_2 + C_3) \parallel C_1 + (C_4 + C_5) \parallel C_6$$

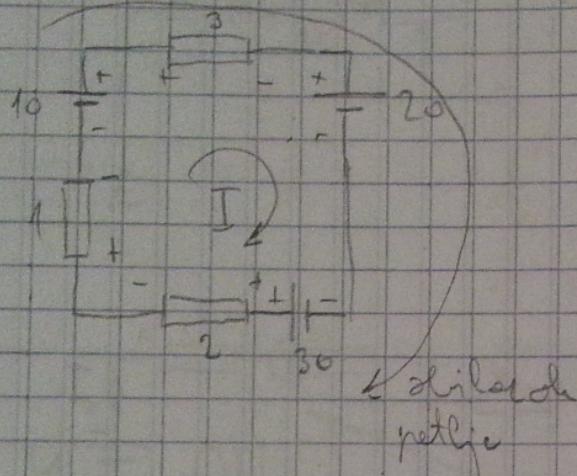


$$R_{\text{A}} = (R_2 \parallel R_3 + R_1) \parallel (R_6 + R_4 \parallel R_5)$$



$$R_{\text{in}} = R_1 \parallel R_5$$

\Rightarrow Kirchh. Lds. 2. u

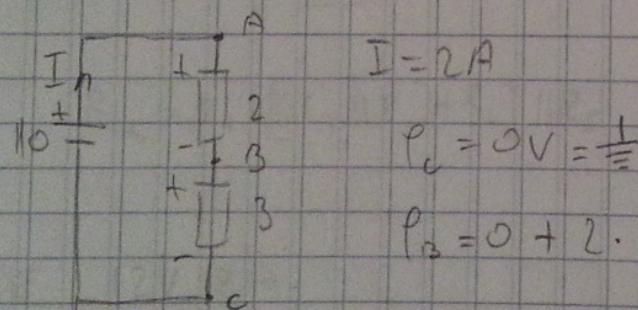


$$-I \cdot 1 + 10 - I \cdot 3 - 20 + 30 - I \cdot 2 = 0$$

(5)

zirkularne
petlige

\Rightarrow Sada učinimo u-, u jedn pisanu + i drugu -



$$I = 2A$$

$$\varphi_C = 0V = \frac{1}{3}$$

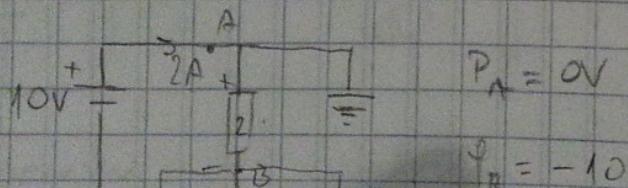
$$\varphi_B = 0 + 2 \cdot 3 = 6V$$

$$\varphi_A = \varphi_B + 2 \cdot 2 = 10$$

ili

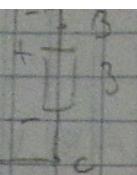
$$\varphi_A = 0 + 10 = 10V$$

\Rightarrow bei uveränderl. nema varl. potencijala



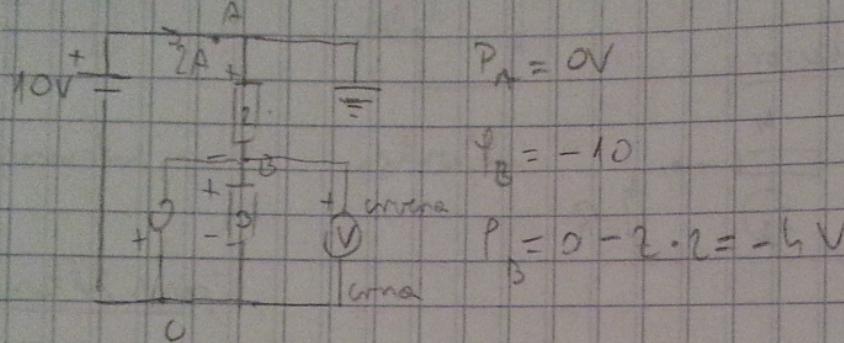
$$\varphi_A = 0V$$

$$\varphi_B = -10$$



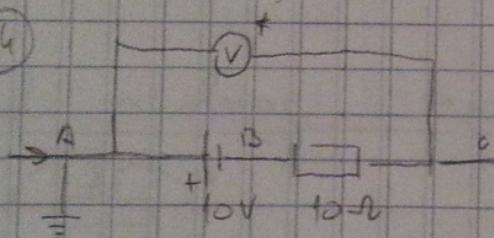
$$\varphi_B = 0 + 2 \cdot 3 = 6V \quad \varphi_A = 0 + 10 = 10V$$

\Rightarrow Bei Widerstand ohne negl. Potenzielle



$$U_V = U_{BC} \neq U_{CA}$$

II. 2 - ④



$$\varphi_A = 0V$$

$$\varphi_C = 0 + 20 = 20V$$

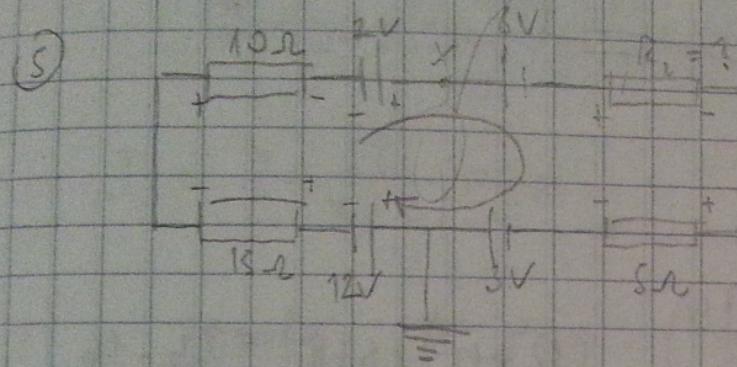
$$\varphi_B = 0 - 10 = -10V$$

$$I = \frac{\varphi_B - \varphi_C}{R} = \frac{-10 - 20}{10} = -3A$$

$$U_V = 20V$$

M1 20th / 20.15

→ základní volným tokem



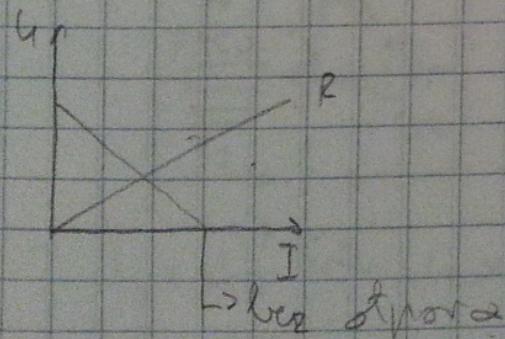
$$R_2 = ?$$

→ φ_1 je zero obecná polohu, φ_2 nám L

1) $\varphi_1 = 0 - 12 - 15I - 10I + 7 = 0 \Rightarrow I = -\frac{1}{5} A$

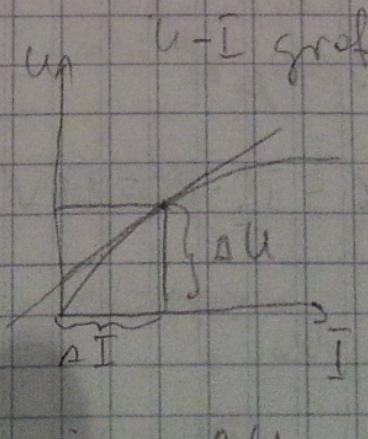
2) $\varphi_1 = 0 - 3 + 5I + IR_2 + 8 \Rightarrow R_2 = 20\Omega$

⇒ statické i dinamické stopy

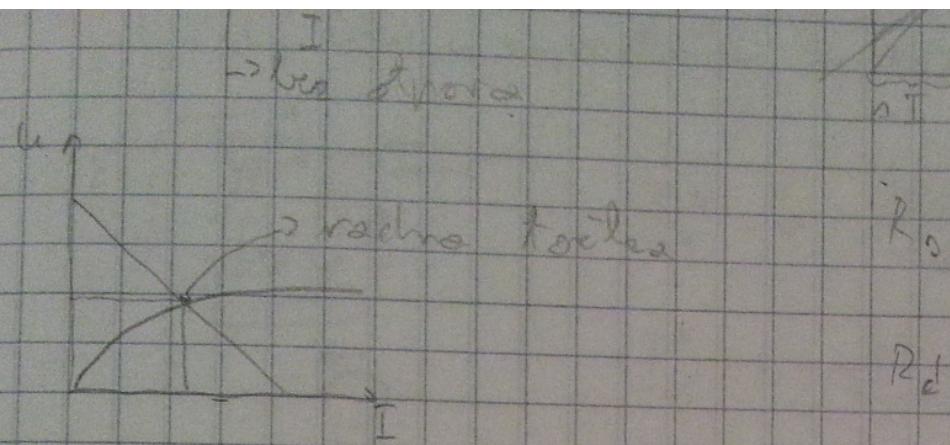


U_I

→ bez stopy



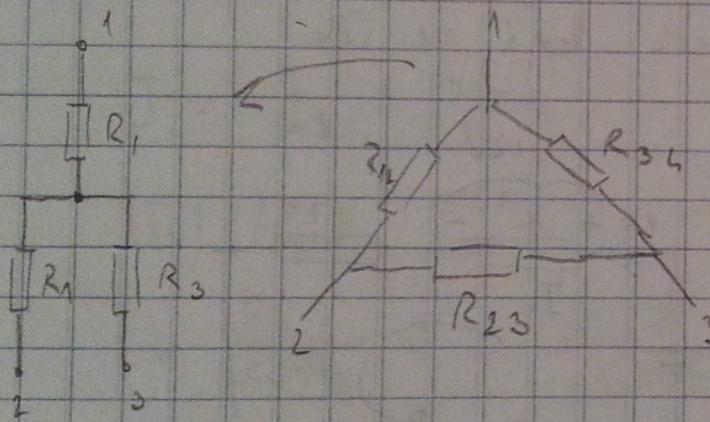
n_1



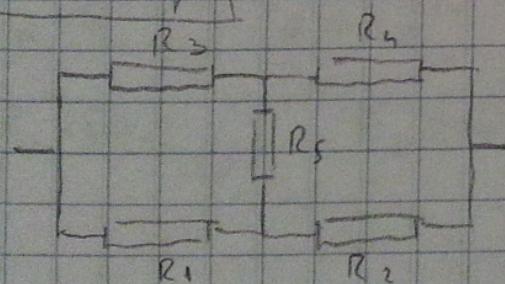
$$R_s = \frac{\Delta U}{\Delta I}$$

$$R_d = \frac{\Delta U}{\Delta I}$$

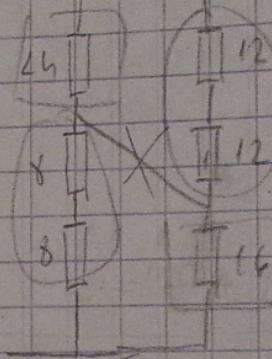
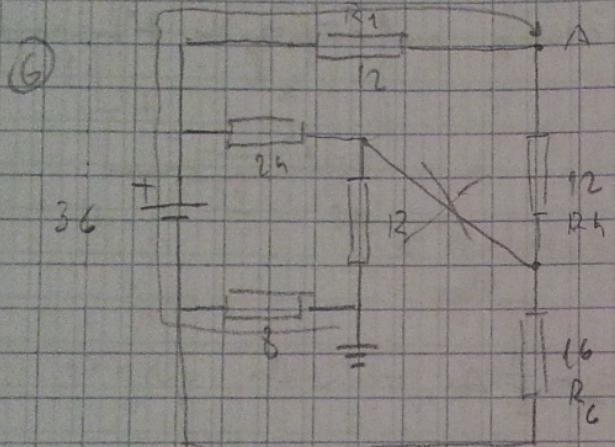
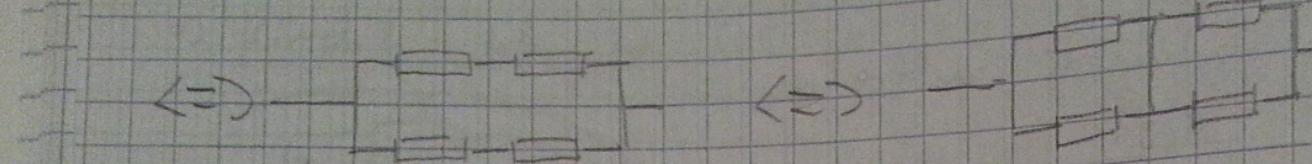
\Rightarrow transformative Arbeit wieder



\Rightarrow messen aufg'



$$R_1 R_3 = R_2 R_4$$



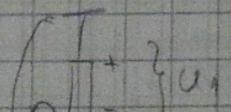
$$(12+12)(8+8) = 24 \cdot 16$$

$$I_1 = \frac{36}{R_1 + R_3 + R_5} = 900 \mu A$$

$$I_2 = \frac{36}{R_1 + R_5 + R_6} = 900 \mu A$$

$$U_A = 0 - I_1 \cdot R_5 + 36 - I_2 \cdot R_1 = 18 V$$

\Rightarrow strujni i naporni člo

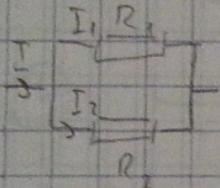


$$U_1 = U \cdot \frac{R_1}{R_1 + R_2}$$

$$P_R = U - I_1 \cdot R_1 + 36 - I_2 \cdot R_2 = 18 \text{ V}$$

\Rightarrow minimi i napojniho vlož.

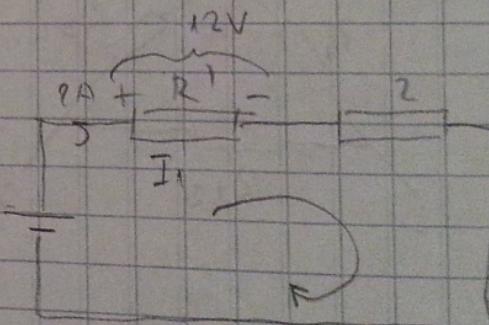
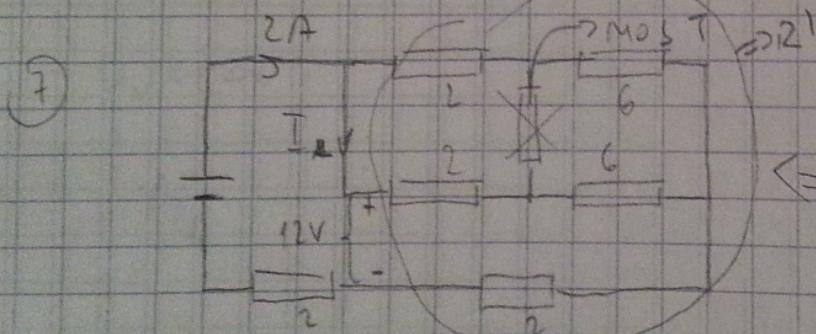
$$\begin{array}{l} U \\ \left\{ \begin{array}{l} U_1 \\ U_2 \end{array} \right. \end{array} \quad U_1 = U \cdot \frac{R_1}{R_1 + R_2} \\ U_2 = U \cdot \frac{R_2}{R_1 + R_2}$$



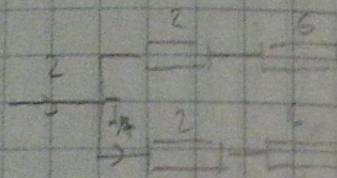
$$I_1 = I \cdot \frac{R_2}{R_1 + R_2}$$

$$I_2 = I \cdot \frac{R_1}{R_1 + R_2}$$

\Rightarrow p. vlož. haji ne ide

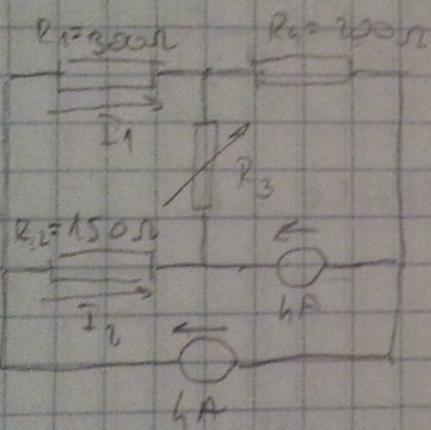


$$I = \frac{12}{6} = 2 \text{ A}$$



$$I_4 = 2 \cdot \frac{3}{8+3} = 1A$$

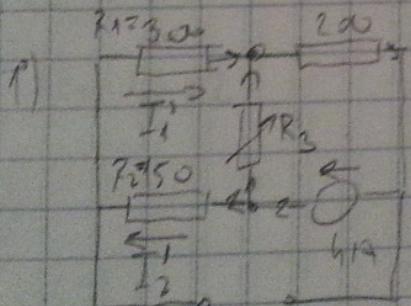
5)



\Rightarrow I₁ r. w. inner = I₁ r. w. outer \Rightarrow gelenk i.w.

\Rightarrow reziprokl. = I₁, 0. \rightarrow —

str. i.w. = p.l. ~0~ \Rightarrow ~0~

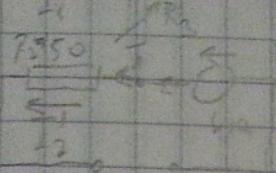


$$I_1' = h \cdot \frac{R_3}{650+R_3} (+)$$

$$I_2' = h \cdot \frac{R_3}{650+R_3} (-)$$

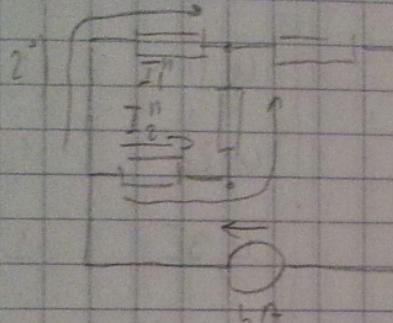
I₁, I₂' are superfluous minor values

$$T_{11} = 1 \cdot 150 + R_3 \quad 1A$$



$$I_1 = h \cdot \frac{R_3}{450 + R_3} (+)$$

I_1, I_2 i I_1' ide u suprođim mjerovima



$$I_1'' = h \cdot \frac{150 + R_3}{450 + R_3} (-)$$

$$I_2'' = h \cdot \frac{300}{450 + R_3} (+)$$

$$I_1 = +I_1' + I_1''$$

$$I_1 = -I_1' + I_1'' =$$

$$|I_1| = |I_1'|$$

$$h \cdot \frac{R_3}{450 + R_3} + h \cdot \frac{150 + R_3}{450 + R_3} = -h \cdot \frac{R_3}{450 + R_3} + h \cdot \frac{300}{450 + R_3}$$

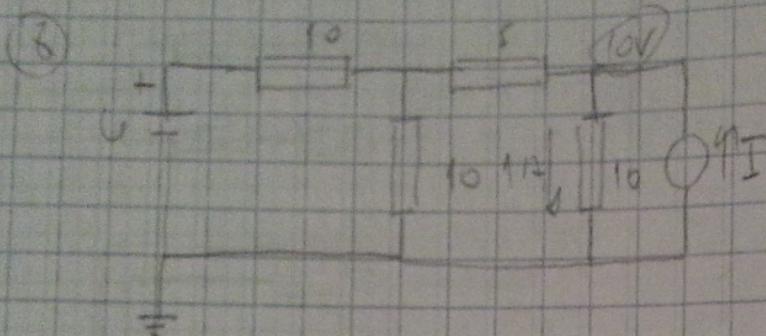
$$|a| = |b|$$

$$a = b$$

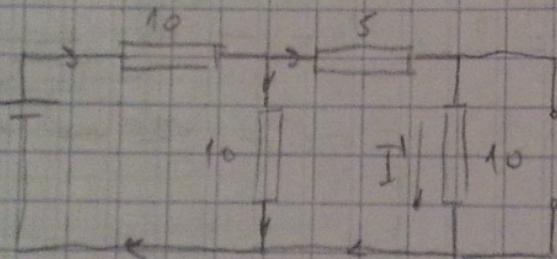
$$a = -b$$

$$R_3 = 5\Omega$$

$$R_3 = -450\Omega$$



1. Schleife

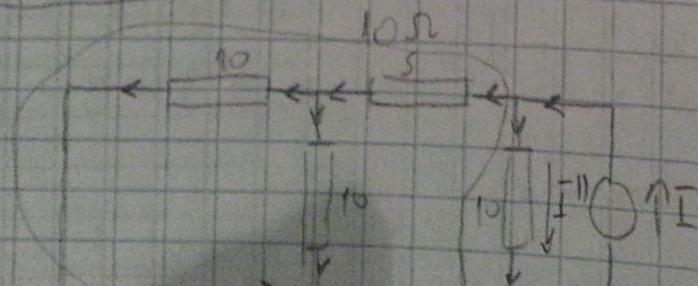


$$R' = 10 \parallel (10 + 5) + 10 = 16$$

$$I_{uh}^{'} = \frac{U}{16}$$

$$I' = I \cdot \frac{10}{25} = \frac{U}{40} (+)$$

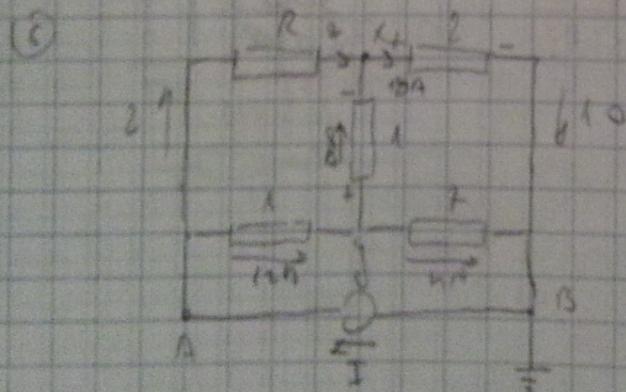
2. Schleife



$$I'' = \frac{I}{2} (+)$$

$$\frac{1}{4} = \frac{4}{40} = 0.1$$

$$E = 200 \cdot 2, I = 20V$$



$$t_1 = 10$$

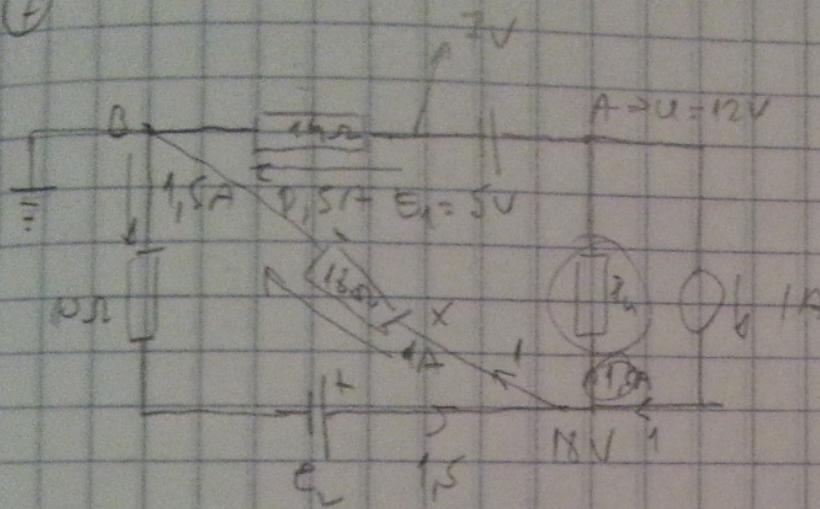
$$f_y = f_x + 3 \cdot 1 = 26 \checkmark$$

$$f_4 = f_3 + (2A - 1) \omega = 90V$$

$$f_2 = 60V$$

$$f_{13} = 0 \text{ V} \quad f_{43} = 40 \text{ V}$$

(2)



$$A \Rightarrow U = 12V$$

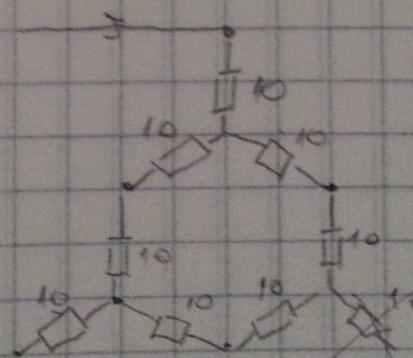
$$R_h = \frac{U}{I} = \frac{12 - 12}{1,5} = \frac{6}{1,5} = 4\Omega$$

(3)

$$I = \frac{U}{R_{th}}$$

$$\begin{aligned} R_{th} &= 10 + 20 // 40 + 10 = \\ &= 100/3 \Omega \end{aligned}$$

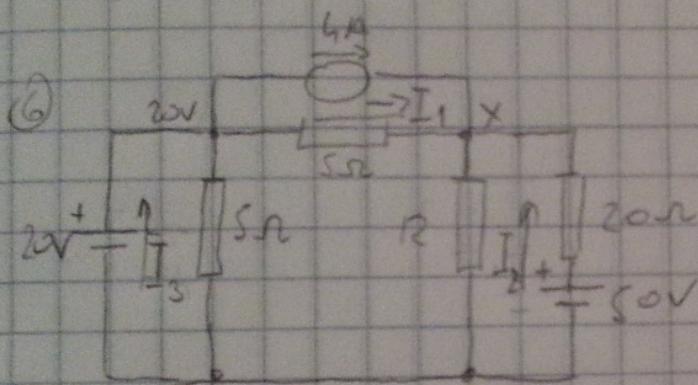
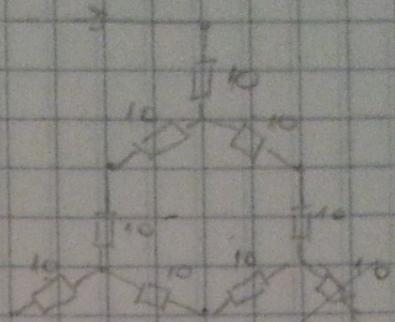
$$I = 3A$$



$$\textcircled{1} \quad I = \frac{U}{R_{\text{sh}}}$$

$$R_{\text{sh}} = 10 + 10 \parallel 40 + 10 = \\ = 100/3 \Omega$$

$$I = 3/4$$



$$U_R = \rho_x - \rho_o = \rho_x$$

$$2\Omega \times: \sum I_{\text{in}} = \sum I_{\text{out}}$$

$$I_2 + I_3 + h = I_1$$

$$\frac{2 - \rho_x}{1} + \frac{50 - \rho_x}{20} + h = \frac{\rho_x - 0}{10} \Rightarrow \rho_x = 30V$$

$$\Delta U = 10$$