



ZALICZENIE

2 kolokwia

50% zalicza

punktacja 0-100

terminy:

1. środa 12 kwietnia

2. pon 12 czerwca

19 czerwca poprawa

aktywność plusy i minusy - dodają się do kolokwium

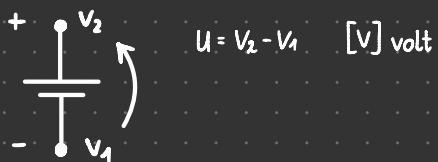
zbiór zadań - ten co na wykładzie

- kalkulatory naukowe

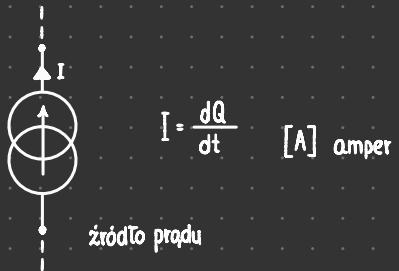
ĆWICZENIA 1

27.02.23

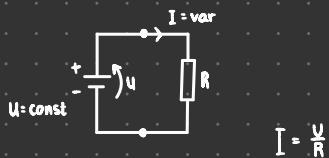
NAPIĘCIE



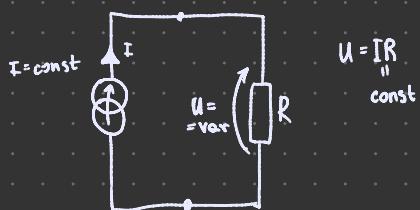
NATĘZENIE



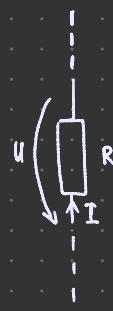
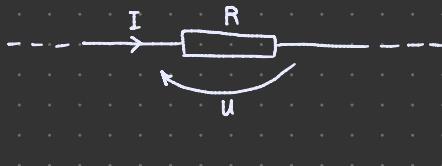
ŽRÓDŁO NAPIĘCIOWE c.v.



ŽRÓDŁO PRĄDOWE c.c.



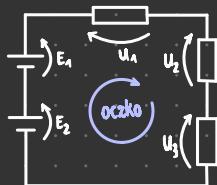
ZNAKOWANIE



PRAWA KIRCHHOFFA

NAPIĘCJOWE w dowolnym oczku obwodu elektrycznego bilans napięć jest 0.

$$\sum U_i = 0$$

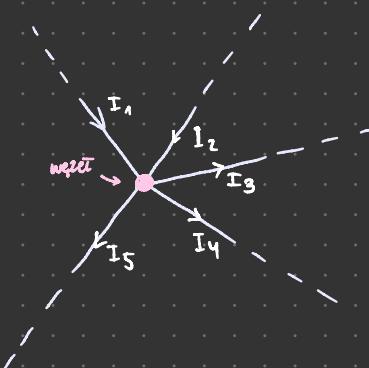


$$+E_1 + E_2 - u_1 - u_2 - u_3 = 0$$

$$E_1 + E_2 = u_1 + u_2 + u_3$$

PRĄDOWE w dowolnym węźle obwodu elektrycznego bilans prądów jest 0.

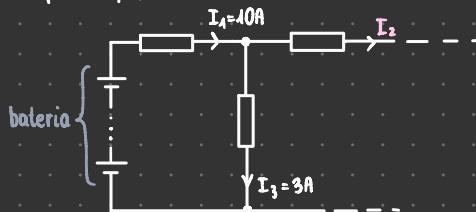
$$\sum I_i = 0$$



$$+I_1 + I_2 - I_3 - I_4 - I_5 = 0$$

$$I_1 + I_2 = I_3 + I_4 + I_5 = 0$$

Zadanie 1 prawo prądowe



$$+I_1 - I_2 - I_3 = 0$$

$$I_2 = 10\text{A} - 3\text{A} = 7\text{A}$$

Zadanie 2 prawo napięciowe

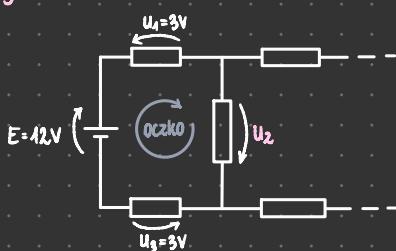


$$+E - U_1 - U_2 = 0$$

$$E - U_2 = U_1$$

$$U_1 = 5\text{V}$$

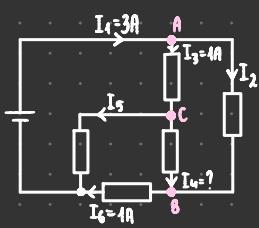
Zadanie 3



$$+E - U_1 + U_2 - U_3 = 0$$

$$12\text{V} - 3\text{V} + U_2 - 3\text{V} = 0 \Rightarrow U_2 = -6\text{V}$$

Zadanie 4 Zapisz bilans prądu



dla węzła A: $I_2 = ?$
 $I_4 - I_3 - I_2 = 0$
 $I_2 = 2\text{A}$

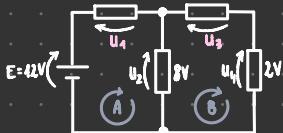
dla węzła B: $I_4 = ?$
 $I_4 - I_6 + I_2 = 0$
 $I_4 = -1\text{A}$

dla węzła C: $I_5 = ?$
 $-I_5 + I_3 - I_4 = 0$
 $I_5 = 2\text{A}$

ćwiczenia 2

06.03.23

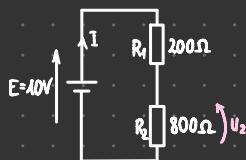
Zadanie 5



$$\begin{aligned} A: \quad & E - U_1 - U_2 = 0 \\ & 12 - U_1 - 8 = 0 \\ & U_1 = 4V \end{aligned}$$

$$\begin{aligned} B: \quad & U_2 - U_3 - U_4 = 0 \\ & 8V - U_3 - 2V = 0 \\ & U_3 = 6V \end{aligned}$$

Zadanie 6



dzielniki: $U_2 = \frac{R_2}{R_1 + R_2} E = \frac{800\Omega}{1000\Omega} \cdot 10V = 8V$

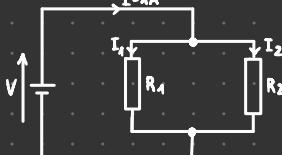
Zadanie 7



$$\begin{aligned} U_1: \quad & U_1 = \frac{R_1}{R_1 + R_2} U \\ & U_1 = \frac{4k\Omega}{3k\Omega} 300V = 100V \end{aligned}$$

$$\begin{aligned} U_2: \quad & U_2 = \frac{R_2}{R_1 + R_2} U \\ & U_2 = \frac{2k\Omega}{3k\Omega} 300V = 200V \end{aligned}$$

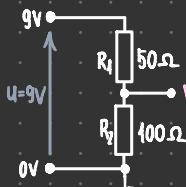
Zadanie 8



$$a) \quad R_1 = R_2 = 100\Omega \quad I_1 = \frac{R_2}{R_1 + R_2} \cdot I = \frac{100\Omega}{200\Omega} \cdot 1A = \frac{1}{2}A$$

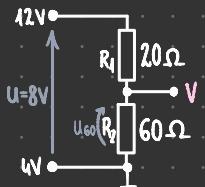
$$b) \quad R_1 = 2\Omega \quad R_2 = 8\Omega \quad I_1 = \frac{R_2}{R_1 + R_2} I = \frac{8\Omega}{10\Omega} 1A = 0.8A$$

Zadanie 9



$$V = \frac{R_2}{R_1 + R_2} U = \frac{100\Omega}{150\Omega} \cdot 9V = 6V$$

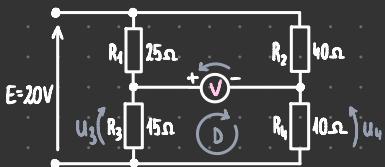
Zadanie 10



$$U_{60} = \frac{R_2}{R_1 + R_2} U = \frac{60\Omega}{80\Omega} 8V = 6V$$

$$V = 6V + 4V = 10V$$

Zadanie 11



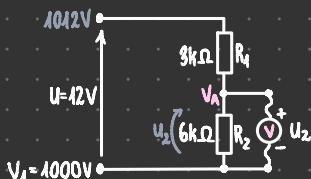
$$D: U_3 - V - U_4 = 0$$

$$U_3 = \frac{R_3}{R_3 + R_4} E = \frac{15\Omega}{40\Omega} 20V = \frac{15}{2}V = 7,5V$$

$$U_4 = \frac{R_4}{R_4 + R_2} E = \frac{10\Omega}{50\Omega} 20V = 4V$$

$$V = 3,5V$$

Zadanie 12



$$U_2 = \frac{R_2}{R_1 + R_2} U = \frac{6\Omega}{9\Omega} 12V = \frac{2}{3} \cdot 12V = 8V$$

$$V_A = 8V + 1000V = 1008V$$

Zadanie 13



$$D: U_3 + V - U_4 = 0$$

$$U_3 = \frac{3k\Omega}{3k\Omega + 7k\Omega} 50V = \frac{3}{10} \cdot 50V = 15V$$

$$U_4 = \frac{1k\Omega}{1k\Omega + 9k\Omega} 50V = \frac{1}{10} \cdot 50V = 5V$$

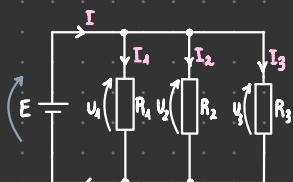
$$V = -10V$$

minus oznacza, że wyższy potencjał po lewej stronie.

ĆWICZENIA 3

13.03.23.

Zadanie 14



$$a) \quad E = 18V \quad R_1 = 2\Omega \quad R_2 = 3\Omega \quad R_3 = 6\Omega \\ U_1 = U_2 = U_3 = E$$

z KIRCHHOFFA

$$I_1 = \frac{U_1}{R_1} = \frac{18V}{2\Omega} = 9A \\ I_2 = \frac{U_2}{R_2} = \frac{18V}{3\Omega} = 6A \\ I_3 = \frac{U_3}{R_3} = \frac{18V}{6\Omega} = 3A$$

$$I = I_1 - I_2 - I_3 = 0 \\ I = 9 + 6 + 3 = 18A$$

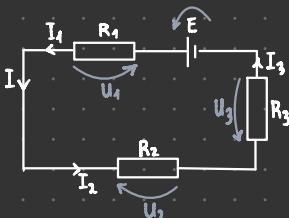
z PRAWA OHMIA

$$I = \frac{E}{R_{123}}$$

$$\frac{1}{R_{123}} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} = \frac{6}{6} \Rightarrow R_{123} = 1\Omega$$

$$I = \frac{18V}{1\Omega} = 18A$$

Zadanie 15



$$a) \quad E = 18V \quad R_1 = 3\Omega \quad R_2 = 9\Omega \quad R_3 = 6\Omega$$

$$I = \frac{E}{R_{123}} = \frac{18V}{18\Omega} = 1A$$

$$I = \frac{U}{R}$$

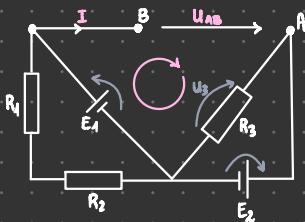
$$U_1 = 1A \cdot 3\Omega = 3V \\ U_2 = 1A \cdot 9\Omega = 9V \\ U_3 = 1A \cdot 6\Omega = 6V$$

$$b) \quad E = 12V \quad R_1 = R_2 = R_3 = 6\Omega$$

$$\text{prąd źródła} \quad I = \frac{12}{18} = \frac{2}{3}$$

$$U_1 = 4V$$

Zadanie 16



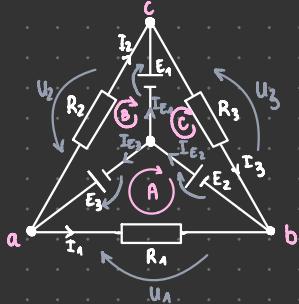
$I = 0A$ - obwód nie jest zamknięty.

$$E_1 = 5V \quad E_2 = 3V \quad R_1 = 3\Omega \quad R_2 = 7\Omega \quad R_3 = 6\Omega$$

$$U_{AB} = U_3 - E_1 = 3 - 5 = -2V$$

Zadanie 17

dane: $E_1 = 8V$ $E_2 = 12V$ $E_3 = 3V$ $R_1 = 3\Omega$ $R_2 = 5\Omega$ $R_3 = 4\Omega$



$$\begin{aligned} A: \quad & U_1 - U_2 - U_3 = 0 \\ & U_1 = E_2 + E_3 \\ & U_1 = 12V + 3V = 15V \\ & I = \frac{U_1}{R_1} = \frac{15}{3} = 5A \end{aligned}$$

$$\begin{aligned} B: \quad & U_3 - U_2 - U_1 = 0 \\ & U_2 = E_3 - E_1 \\ & U_2 = 3V - 8V = -5V \\ & I_2 = \frac{U_2}{R_2} = \frac{-5}{5} = -1A \end{aligned}$$

$$\begin{aligned} C: \quad & E_1 - U_3 + E_2 = 0 \\ & U_3 = E_1 + E_2 \\ & U_3 = 8V + 12V = 20V \\ & I_3 = \frac{U_3}{R_3} = \frac{20V}{4\Omega} = 5A \end{aligned}$$

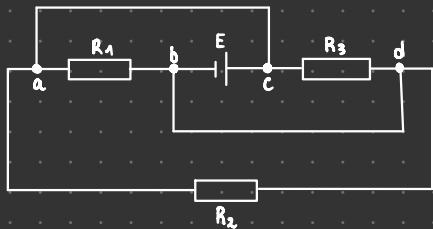
$$a: \quad \begin{aligned} I_{E_3} - I_2 - I_1 &= 0 \\ I_{E_3} &= I_2 + I_1 = 4A \end{aligned}$$

$$b: \quad \begin{aligned} -I_{E_2} + I_3 + I_4 &= 0 \\ I_{E_2} &= I_3 + I_4 = 10A \end{aligned}$$

$$c: \quad \begin{aligned} I_{E_1} - I_3 + I_2 &= 0 \\ I_{E_1} &= I_3 - I_2 = 6A \end{aligned}$$

Zadanie 18

$E = 18V$ $R_1 = 3\Omega$ $R_2 = 9\Omega$ $R_3 = 6\Omega$



$$\frac{1}{R_{123}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{3} + \frac{1}{9} + \frac{1}{6} = \frac{11}{18}$$

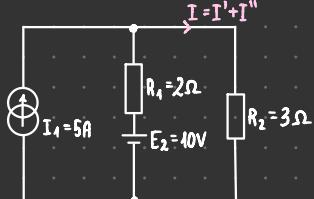
$$R_{123} = \frac{18}{11}$$

SUPERPOZYCJA

ĆWICZENIA 4

20.03.23

Zadanie 19



1.

$$I' = \frac{E_1}{R_{12}}$$

$$R_{12} = 3\Omega + 2\Omega = 5\Omega$$

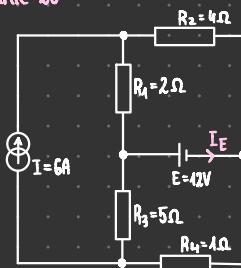
$$I' = \frac{10V}{5\Omega} = 2A$$

2.

$$I'' = \frac{R_1}{R_1 + R_2} I_1 = \frac{2}{5} \cdot 5 = 2A$$

3. $I = 2A + 2A = 4A$

Zadanie 20



4

$$I_{R_4} = I \cdot \frac{R_2}{R_2 + R_3} = 6 \cdot \frac{4}{6} = 4A$$

$$I_{R_3} = I \cdot \frac{R_3}{R_2 + R_3} = 6 \cdot \frac{2}{6} = 2A$$

wzór c prawo Kirchhoffa

$$I_{R_4} - I_{R_3} - I_{E'} = 0$$

$$4A - 2A = I_{E'} = 3A$$

2

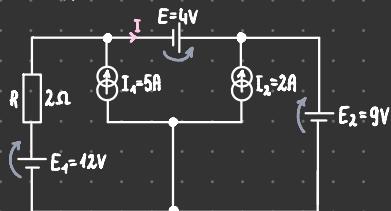
$$\left. \begin{array}{l} R_{12} = 6\Omega \\ R_{1234} = 3 \end{array} \right\} \frac{1}{R_{1234}} = \frac{1}{6} + \frac{1}{6} = \frac{2}{6}$$

$$\left. \begin{array}{l} R_{34} = 6\Omega \\ I_{E''} = \frac{E}{R_{1234}} = \frac{42}{3} = 14A \end{array} \right\} I_{E''} = 14A$$

3

$$I_E = I_{E'} + I_{E''} = 3A + 14A = 17A$$

Zadanie 21



1



$$I' = \frac{E_1}{R} = \frac{12}{2} = 6A$$

2



$$I'' = 5A$$

3



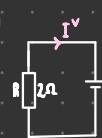
$$I''' = 0A$$

4



$$I^W = \frac{6V}{2\Omega} = 3A$$

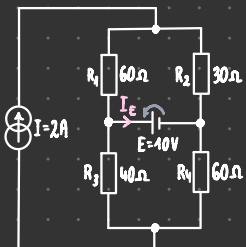
5



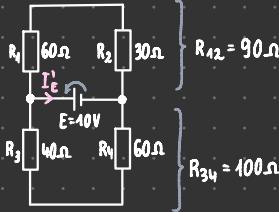
$$I^V = \frac{9V}{2\Omega} = -4,5A$$

$$I = 6A + 5A + 0A + 2A - 4,5A = 8,5A$$

Zadanie 22



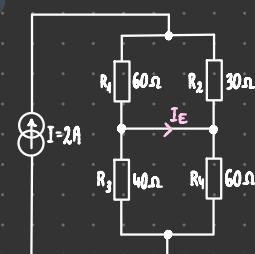
1



$$\frac{1}{R_{1234}} = \frac{1}{90} + \frac{1}{100} = \frac{190}{9000} \Rightarrow R_{1234} = \frac{900}{19}$$

$$I_E = -\frac{E}{R_{1234}} = -\frac{10}{\frac{900}{19}} = -\frac{19}{90}$$

2



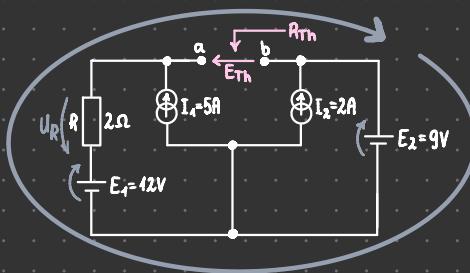
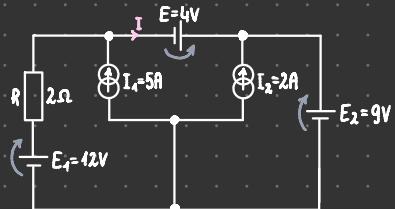
$$I_{R_4} = \frac{30}{90} \cdot 2 = \frac{2}{3}$$

$$I_{R_3} = \frac{60}{100} \cdot 2 = 1,2$$

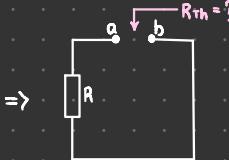
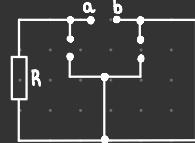
$$I_{R_4} - I_E - I_{R_3} = 0 \\ I_E = \frac{2}{3} - 1,2 = -\frac{8}{90}A$$

$$I_E = I_{E'} + I_{E''} = -\frac{8}{45} - \frac{49}{90} = -\frac{67}{90}$$

Zadanie 23



$$R_{th} = ?$$



$$R_{th} = R = 2\Omega$$

$$E_{th} = ? \quad (\% \text{ oczka})$$

$$-U_R + E_1 - E_{th} - E_2 = 0$$

$$E_{th} = -U_R + E_1 - E_2$$

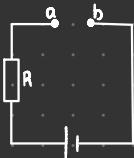
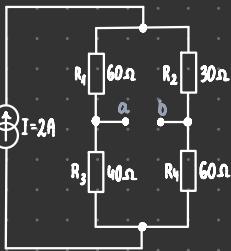
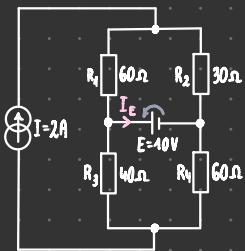
$$\left. \begin{array}{l} U_R = 0 + (-I; R) \\ U_R = -5 \cdot 2 = -10V \end{array} \right\} \text{superpozycja}$$

$$E_{th} = 10 + 12 - 9 = 13V$$

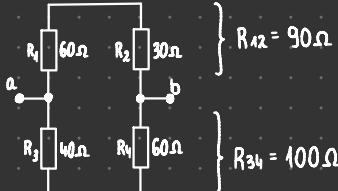
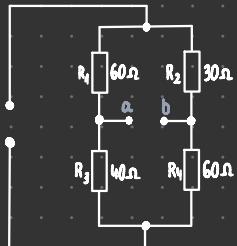


$$I = \frac{E_{th} + E}{R_{th}} = \frac{13 + 4}{2} = 8,5A$$

Zadanie 24



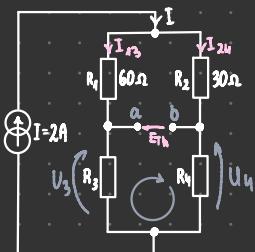
$$R_{Th} = ?$$



$$\frac{1}{R_{Th}} = \frac{1}{90\Omega} + \frac{1}{400\Omega} = \frac{190}{3600\Omega}$$

$$R_{Th} = \frac{3600}{190} \Omega$$

$$E_{Th} = ?$$



$$I_{13} = \frac{R_{24}}{R_{13} + R_{24}} I = \frac{90}{190} \cdot 2A = \frac{18}{19} A$$

$$I_{24} = \frac{R_{13}}{R_{13} + R_{24}} I = \frac{100}{190} \cdot 2A = \frac{10}{19} A$$

$$U_3 = I_{13} \cdot R_3 = \frac{18}{19} \cdot 40 = 37,9V$$

$$U_4 = I_{24} \cdot R_4 = \frac{10}{19} \cdot 60 = 63,2V$$

z oczka:

$$U_3 - E_{Th} - U_4 = 0$$

$$E_{Th} = U_3 - U_4 = 37,9V - 63,2V = -25,3V$$

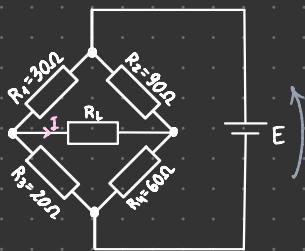


$$E_{Th} - U_R - E = 0$$

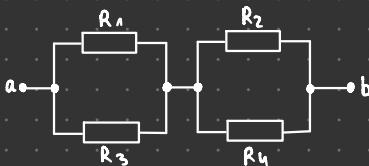
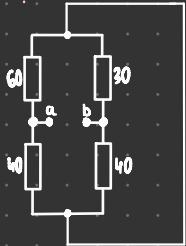
$$U_R = E_{Th} - E = -25,3V - 10V = -35,3V$$

$$I_E = \frac{U_R}{R_{Th}} = -\frac{35,3V}{47,39\Omega} = -0,74A$$

Zadanie 25



$$R_{Th} = ?$$



$$\frac{1}{R_{13}} = \frac{1}{30} + \frac{1}{20} = \frac{50}{600} \Rightarrow R_{13} = 12$$

$$\frac{1}{R_{24}} = \frac{1}{90} + \frac{1}{60} = \frac{150}{5400} \Rightarrow R_{24} = \frac{540}{15} = 36$$

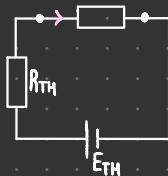
$$R_{Th} = 12 + 36 = 48 \Omega$$

$$U_3 = E \frac{R_3}{R_3 + R_1}$$

$$U_4 = E \frac{R_4}{R_2 + R_4}$$

$$-E_{Th} + U_3 - U_4 = 0$$

$$E_{Th} = E \left(\frac{R_3}{R_3 + R_1} - \frac{R_4}{R_2 + R_4} \right) = E \left(\frac{2}{5} - \frac{2}{5} \right) = 0$$



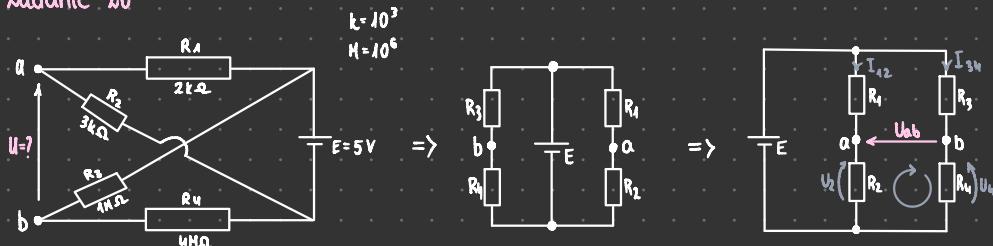
$$I_L = 0A$$

ĆWICZENIA 6

03.04.2023

next: kolos test ABCD na zdalnym po tym kolos.

Zadanie 26



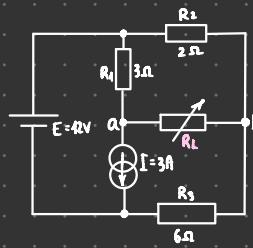
$$U_2 = \frac{R_2}{R_1 + R_2} E = \frac{3\text{k}\Omega}{3\text{k}\Omega + 2\text{k}\Omega} 5\text{V} = 3\text{V}$$

$$U_4 = \frac{R_4}{R_3 + R_4} E = \frac{4\text{M}\Omega}{4\text{M}\Omega + 4\text{M}\Omega} 5\text{V} = 4\text{V}$$

$$U_2 - U_{ab} - U_4 = 0$$

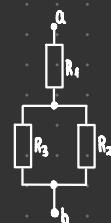
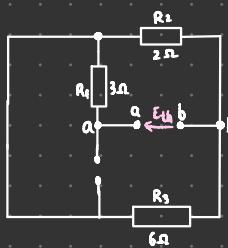
$$U_{ab} = U_2 - U_4 = -1\text{V}$$

Zadanie 27



$$R_L = ?$$

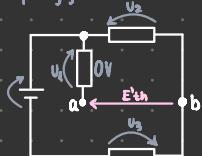
$$P_{\text{MAX}} = ?$$



$$R_{Th} = R_1 + R_2 \parallel R_3$$

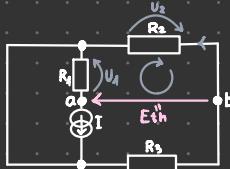
$$R_{Th} = R_1 + \frac{R_2 R_3}{R_2 + R_3} = 3 + \frac{2 \cdot 6}{2+6} = 3 + \frac{12}{8} = 4,5\Omega$$

-superpozycja-



$$E'_{Th} = U_2$$

$$U_2 = U \cdot \frac{R_2}{R_{23}} = 12 \cdot \frac{2}{8} = 3\text{V}$$



$$E''_{Th} + U_1 + U_2 = 0$$

$$U_2 = 0$$

$$E''_{Th} = -U_1$$

$$U_1 = 3\text{A} \cdot 3\Omega = 9\text{V}$$

$$E''_{Th} = -9\text{V}$$

$$E_{Th} = -9\text{V} + 3\text{V} = -6\text{V}$$

$$R_{Th} = R_{Th} = 4,5\Omega$$

$$P = U \cdot J = \frac{U^2}{R_{Th}} = \frac{1}{4} \cdot \frac{E_{Th}^2}{R_{Th}} = 2\text{W}$$

ĆWICZENIA 7

12.04.23

Zadanie 28

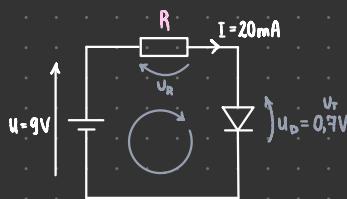


$$U_T = 0,7V$$

$$U_R = U - U_D = 12 - 0,7 = 11,3V$$

$$I = \frac{U_R}{R} = \frac{11,3}{1k} = 11,3mA$$

Zadanie 29



$$U_R = U - U_T = 9 - 0,7 = 8,3V$$