

**Zadanie:**

Oblicz wartości prądów płynących przez wszystkie rezystory.

$$R_1=R_2=R_3=R_4=R_5=R_6=R_7=R_8=R_9=R_{10}=R_{11}=R_{12}=R_{13}=R_{14}=10\Omega,$$

$$E=10V.$$

**Rozwiązanie zadania:**

Obliczenie rezystancji zastępczej obwodu:

$$R_{11,14} = R_{11} + R_{14} = 10\Omega + 10\Omega = 20\Omega$$

$$R_{11,14,12} = \frac{R_{11,14} \cdot R_{12}}{R_{11,14} + R_{12}} = \frac{20\Omega \cdot 10\Omega}{20\Omega + 10\Omega} = 6,67\Omega$$

$$R_{11,14,12,13} = R_{11,14,12} + R_{13} = 6,67\Omega + 10\Omega = 16,67\Omega$$

$$R_{11,14,12,13,10} = \frac{R_{11,14,12,13} \cdot R_{10}}{R_{11,14,12,13} + R_{10}} = \frac{16,67\Omega \cdot 10\Omega}{16,67\Omega + 10\Omega} = 6,25\Omega$$

$$R_{11,14,12,13,10,9} = R_{11,14,12,13,10} + R_9 = 6,25\Omega + 10\Omega = 16,25\Omega$$

$$R_{11,14,12,13,10,9,8} = \frac{R_{11,14,12,13,10,9} \cdot R_8}{R_{11,14,12,13,10,9} + R_8} = \frac{16,25\Omega \cdot 10\Omega}{16,25\Omega + 10\Omega} = 6,19\Omega$$

$$R_{11,14,12,13,10,9,8,7} = R_{11,14,12,13,10,9,8} + R_7 = 6,19\Omega + 10\Omega = 16,19\Omega$$

$$R_{11,14,12,13,10,9,8,7,6} = \frac{R_{11,14,12,13,10,9,8,7} \cdot R_6}{R_{11,14,12,13,10,9,8,7} + R_6} = \frac{16,19\Omega \cdot 10\Omega}{16,19\Omega + 10\Omega} = 6,18\Omega$$

$$R_{11,14,12,13,10,9,8,7,6,3} = R_{11,14,12,13,10,9,8,7,6} + R_3 = 6,18\Omega + 10\Omega = 16,18\Omega$$

$$R_{11,14,12,13,10,9,8,7,6,3,4} = \frac{R_{11,14,12,13,10,9,8,7,6,3} \cdot R_4}{R_{11,14,12,13,10,9,8,7,6,3} + R_4} = \frac{16,18\Omega \cdot 10\Omega}{16,18\Omega + 10\Omega} = 6,18\Omega$$

$$R_{11,14,12,13,10,9,8,7,6,3,4,5} = R_{11,14,12,13,10,9,8,7,6,3,4} + R_5 = 6,18\Omega + 10\Omega = 16,18\Omega$$

$$R_{11,14,12,13,10,9,8,7,6,3,4,5,2} = \frac{R_{11,14,12,13,10,9,8,7,6,3,4,5} \cdot R_2}{R_{11,14,12,13,10,9,8,7,6,3,4,5} + R_2} = \frac{16,18\Omega \cdot 10\Omega}{16,18\Omega + 10\Omega} = 6,18\Omega$$

$$R_{11,14,12,13,10,9,8,7,6,3,4,5,2,1,w} = R_{11,14,12,13,10,9,8,7,6,3,4,5,2} + R_1 + R_w = 6,18\Omega + 10\Omega + 10\Omega = 26,18\Omega$$

Obliczenia dokładne rezystancji zastępczej

$R_{11,14}$	=20	$\Omega$
$R_{11,14,12}$	=6,666667	$\Omega$
$R_{11,14,12,13}$	=16,666667	$\Omega$
$R_{11,14,12,13,10}$	=6,25	$\Omega$
$R_{11,14,12,13,10,9}$	=16,25	$\Omega$
$R_{11,14,12,13,10,9,8}$	=6,190476	$\Omega$
$R_{11,14,12,13,10,9,8,7}$	=16,19048	$\Omega$
$R_{11,14,12,13,10,9,8,7,6}$	=6,181818	$\Omega$
$R_{11,14,12,13,10,9,8,7,6,3}$	=16,18182	$\Omega$
$R_{11,14,12,13,10,9,8,7,6,3,4}$	=6,180556	$\Omega$
$R_{11,14,12,13,10,9,8,7,6,3,4,5}$	=16,18056	$\Omega$
$R_{11,14,12,13,10,9,8,7,6,3,4,5,2}$	=6,180371	$\Omega$
$R_{11,14,12,13,10,9,8,7,6,3,4,5,2,1,w}$	=26,18037	$\Omega$

## Obliczanie wartości prądów i napięć:

$$I_1 = \frac{E}{R_z} = \frac{10V}{26,18\Omega} = 0,382A$$

$$U_2 = E - I_1 \cdot (R_w + R_1) = 10V - 0,382A \cdot (10\Omega + 10\Omega) = 2,36V$$

$$I_2 = \frac{U_2}{R_2} = \frac{2,36V}{10\Omega} = 0,236A$$

$$I_5 = I_1 - I_2 = 0,382A - 0,236A = 0,146A$$

$$U_5 = I_5 \cdot R_5 = 0,146A \cdot 10\Omega = 1,46V$$

$$U_4 = U_2 - U_5 = 2,36V - 1,46V = 0,902V$$

$$I_4 = \frac{U_4}{R_4} = \frac{0,902V}{10\Omega} = 0,0902A$$

$$I_3 = I_1 - I_2 - I_4 = 0,382A - 0,236A - 0,0902A = 0,0557A$$

$$U_3 = I_3 \cdot R_3 = 0,0557A \cdot 10\Omega = 0,557V$$

$$U_6 = U_4 - U_3 = 0,902V - 0,557V = 0,344V$$

$$I_6 = \frac{U_6}{R_6} = \frac{0,344V}{10\Omega} = 0,0344A$$

$$I_7 = I_3 - I_6 = 0,0557A - 0,0344A = 0,0213A$$

$$U_7 = I_7 \cdot R_7 = 0,0213A \cdot 10\Omega = 0,213V$$

$$U_8 = U_6 - U_7 = 0,344V - 0,213V = 0,131V$$

$$I_8 = \frac{U_8}{R_8} = \frac{0,131V}{10\Omega} = 0,0131A$$

$$I_9 = I_5 - I_4 - I_6 - I_8 = 0,146A - 0,0902A - 0,0344A - 0,0131A = 0,0081A$$

$$U_9 = I_9 \cdot R_9 = 0,0081A \cdot 10\Omega = 0,081V$$

$$U_{10} = U_8 - U_9 = 0,131V - 0,081V = 0,0507V$$

$$I_{10} = \frac{U_{10}}{R_{10}} = \frac{0,0507V}{10\Omega} = 0,00507A$$

$$I_{13} = I_9 - I_{10} = 0,0081A - 0,00507A = 0,00304A$$

$$U_{13} = I_{13} \cdot R_{13} = 0,00304A \cdot 10\Omega = 0,0304V$$

$$U_{12} = U_{10} - U_{13} = 0,0507V - 0,0304V = 0,0203V$$

$$I_{12} = \frac{U_{12}}{R_{12}} = \frac{0,0203V}{10\Omega} = 0,00203A$$

$$I_{11} = I_7 - I_8 - I_{10} - I_{12} = 0,0213A - 0,0131A - 0,00507A - 0,00203A = 0,00101A$$

$$U_{11} = I_{11} \cdot R_{11} = 0,00101A \cdot 10\Omega = 0,0101V$$

$$U_{14} = I_{11} \cdot R_{14} = 0,00101A \cdot 10\Omega = 0,0101V$$

## Obliczania dokładne prądów i napięć

$I_1$	=0,381966	A
$U_2$	=2,360689	V
$I_2$	=0,236069	A
$I_5$	=0,145897	A
$U_5$	=1,458967	V
$U_4$	=0,901722	V
$I_4$	=0,090172	A
$I_3$	=0,055724	A
$U_3$	=0,557244	V
$U_6$	=0,344478	V
$I_6$	=0,034448	A
$I_7$	=0,021277	A
$U_7$	=0,212766	V
$U_8$	=0,131712	V
$I_8$	=0,013171	A
$I_9$	=0,008105	A
$U_9$	=0,081054	V
$U_{10}$	=0,050659	V
$I_{10}$	=0,005066	A
$I_{13}$	=0,00304	A
$U_{13}$	=0,030395	V
$U_{12}$	=0,020263	V
$I_{12}$	=0,002026	A
$I_{11}$	=0,001013	A
$U_{11}$	=0,010132	V
$U_{14}$	=0,010132	V