INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Název projektu**: Automatizace výrobních procesů ve strojírenství a řemeslech**
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Tento projekt je spolufinancován Evropskou unií a státním rozpočtem České republiky

Produkt:

Zavádění cizojazyčné terminologie do výuky odborných předmětů a do laboratorních cvičení

DC circuits with a single source

Návod v anglickém jazyce

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Prepared by: Ing. Jitka Roubalová; translated by: Mgr. Marie Mádlová

DC circuits with a single source

This topic deals with electrical DC circuits with a single source of DC voltage and resistive load.

The load is made up by several resistors that are connected in series, parallelly, or combined through different topographies.

When solving this task, we have to reduce the load to one single resistor. Then applying Ohm´s Law we can determine the value of current taken from the source. Then we gradually convert the simple circuit back up to the initial resistors connections. Now we are able to derive the currents in each of the circuit branches and the voltage of each element of the circuit.

For better understanding here are some examples and solutions.

Example 1:

What is the value of the current taken from the source and the voltage on resistors 1 and 2 when we have the circuit as in the fig. 1

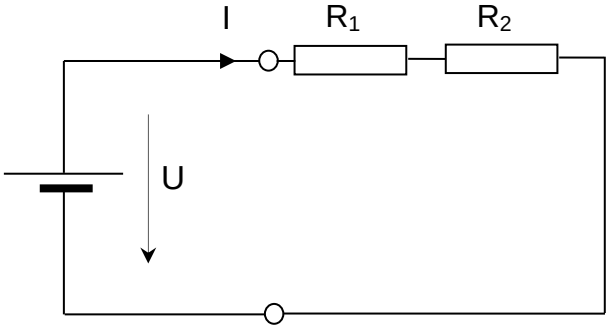
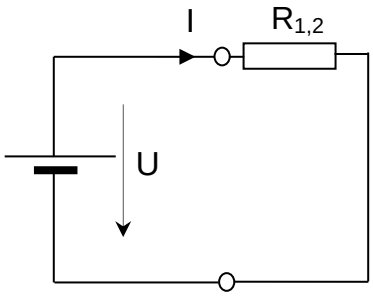


fig. 1

First we replace the load by only one resistor, it must get the same effect as in the initial circuit.

Resistors are connected in series , so the resulting resistance is $R_{1,2} = R_1 + R_2$.

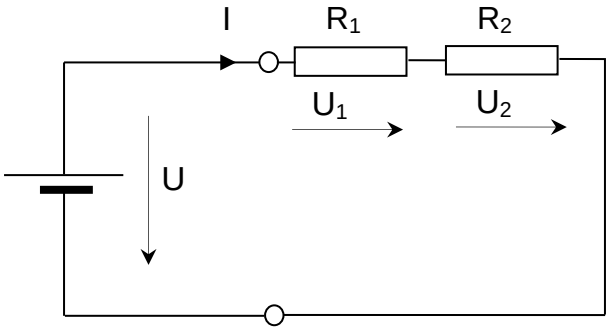
See the new auxiliary circuit



Current taken from the source is :

$$I = \frac{U}{R_{1,2}}$$

Now we convert the circuit back to the initial circuit and calculate the voltage of each resistor seperately.



$$U_1 = I \cdot R_1 \qquad U_2 = I \cdot R_2$$

Example 2:

What is the value of the current taken from the source ,the voltage of resistors R_1 , R_2 a R_3 and currents flowing in the branches when we have the circuit as in fig. 2

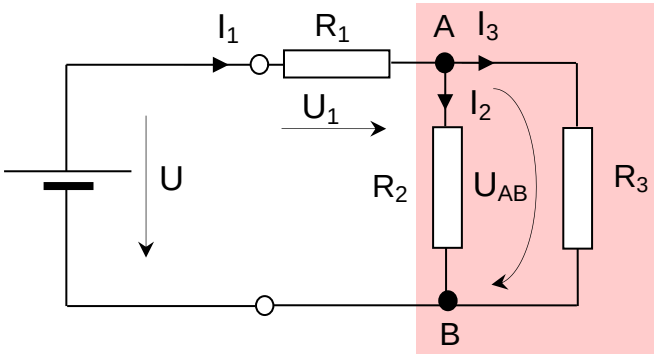
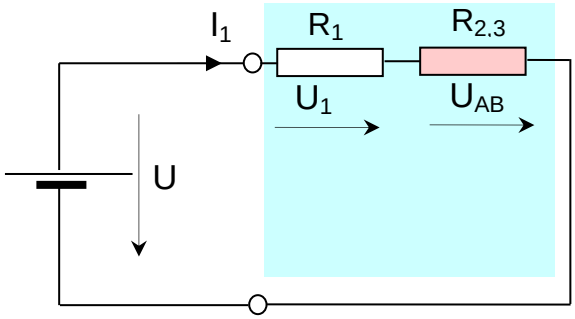


Fig.2

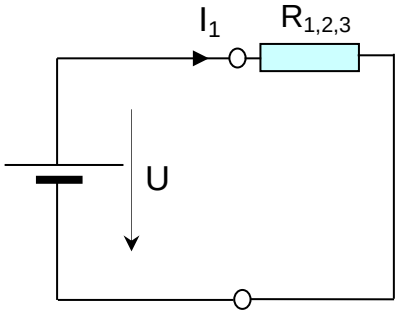
Resistors are connected parallelly , therefore if we replace them by R_{23} , its resistance is

$$\frac{1}{R_{2,3}} = \frac{1}{R_1} + \frac{1}{R_2} \qquad \text{so} \qquad R_{2,3} = \frac{R_2 \cdot R_3}{R_2 + R_3}$$

We get the following simple circuit



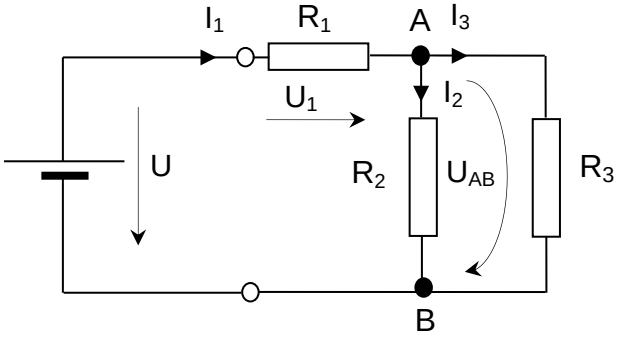
The result resistor $R_{1,2,3} = R_1 + R_{2,3}$. So the auxiliar circuit is :



And we can calculate the current I_1:

$$I_1 = \frac{U}{R_{1,2,3}}$$

Now we convert the circuit back to the initial circuit and gradually calculate voltages of each resistor and currents in each circuit branches :



$$U_1 = R_1 \cdot I_1 \qquad U_{AB} = U - U_1$$

$$I_2 = \frac{U_{AB}}{R_2} \qquad I_3 = \frac{U_{AB}}{R_3}$$

Note:

We can solve such and similar examples by more than one possible way of solutions to get the values of voltage and currents. Here is another procedure how to solve it and get the same and correct results:

The first step: simplifying the circuit and calculating the total current $I_1$and voltage U_1

$$I_1 = \frac{U}{R_{1,2,3}} \qquad U_1 = R_1 \cdot I_1$$

Next step is different and also possible :

$$U_{AB} = I \cdot R_{2,3} \qquad I_2 = \frac{U_{AB}}{R_2} \qquad I_3 = I_1 - I_2$$

The result is the same for both procedures.

Example 3:

What are the current and voltage values of all elements of the circuit in the fig. 3?

The values of the circuit elements are: U=48V, R_1=2Ω, R_2=15Ω, R_3=8Ω, R_4=3Ω, R_5=6Ω.

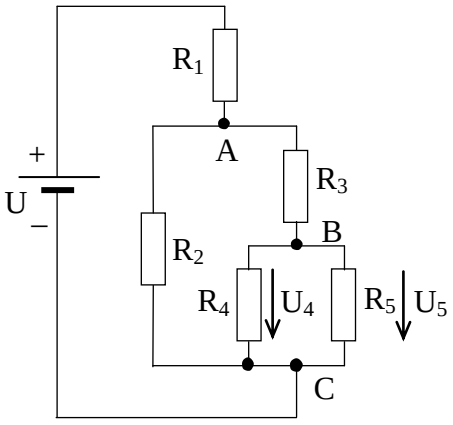


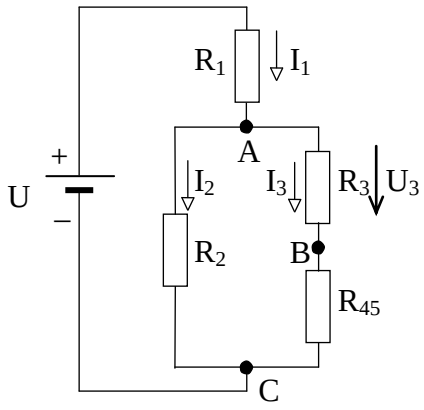
fig. 3

We solve this circuit by the gradual simplifying of the connected resistors. First we derive the resistance of parallely connected resistors R_4 and R_5, then we draw the simplified diagram.

Following formula is applied:

$$R_{45} = \frac{R_4 R_5}{R_4 + R_5} = \frac{3 \cdot 6}{3 + 6} = 2\Omega$$

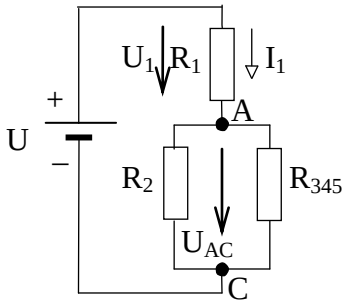
The simplified circuit is :



Resistors R_3 and R_{45} are connected in series, resulting resistence is

$$R_{345} = R_3 + R_{45} = 8 + 2 = 10\Omega$$

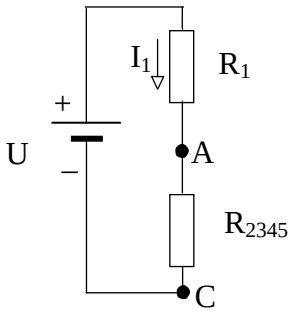
Now we get the simplified diagram



We substitude resistors R_2 and R_{345} that are parallely connected by resistor R_{2345},and we calculate its value using following

$$R_{2345} = \frac{R_2 R_{345}}{R_2 + R_{345}} = \frac{15 \cdot 10}{15 + 10} = 6\Omega$$

Here is the auxiliary circuit



Resistors R_1 and R_{2345} are connected in series, the total result resistance of the auxiliary circuit is

$$R_C = R_1 + R_{2345} = 2 + 6 = 8\Omega$$

The total current taken from the source is

$$I_1 = \frac{U}{R_C} = \frac{48}{8} = 6\,A$$

Voltage U_1 of the resistor R_1 is following:

$$U_1 = R_1 I_1 = 2 \cdot 6 = 12V$$

Voltage U_{AC} between nodes A and C is following:

$$U_{AC} = R_{2345} \cdot I_1 = 6 \cdot 6 = 36V$$

Calculate the currents I_2 and I_3:

$$I_2 = \frac{U_{AC}}{R_2} = \frac{36}{15} = 2{,}4\,A$$

$$I_3 = \frac{U_{AC}}{R_{345}} = \frac{36}{10} = 3{,}6\,A$$

Calculate voltage values of the resistors R_2 and R_3 using the values of currents I_2 a I_3 :

$$U_2 = R_2 I_2 = 15 \cdot 2{,}4 = 36V$$

$$U_3 = R_3 I_3 = 8 \cdot 3{,}6 = 28{,}8V$$

Now calculate the voltage between nodes B and C:

$$U_{BC} = U_4 = U_5$$

$$U_{BC} = R_{45} \cdot I_3 = 2 \cdot 3{,}6 = 7{,}2V$$

From the value of voltage U_{BC} we derive the currents value I_4 and I_5 in resistors R_4 a R_5 :

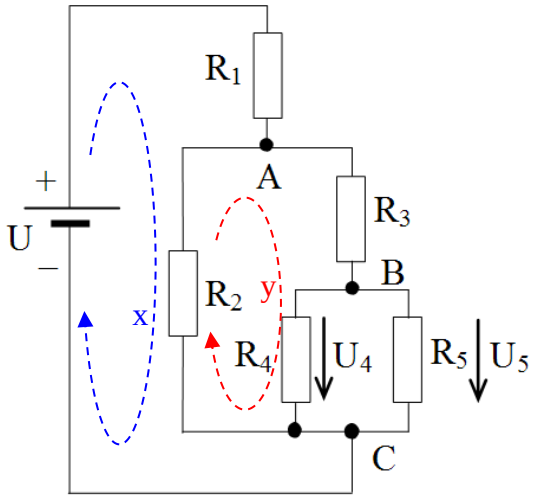
$$I_4 = \frac{U_{BC}}{R_4} = \frac{7,2}{3} = 2,4\,A$$

$$I_5 = \frac{U_{BC}}{R_5} = \frac{7,2}{6} = 1,2\,A$$

This is the final result.

Note .: We can check the results by approving the currents of the nodes and voltage of the loops applying Kirchhoff´s Laws.

You have to apply I.Kirchhoff´s Law for the nc



$$I_1 - I_2 - I_3 = 0$$

$$6 - 2,4 - 3,6 = 0$$

For the node B apply:

$$I_3 - I_4 - I_5 = 0$$

$$3,6 - 2,4 - 1,2 = 0$$

For the node C apply:

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

$$2,4 + 2,4 + 1,2 - 6 = 0$$

You have to apply II. Kirchhof´s Law for the loop x:

$$U_1 + U_2 - U = 0\,,$$

$$12 + 36 - 48 = 0\,.$$

For the loop y apply the following:

$$U_3 + U_4 - U_2 = 0\,,$$

$$28,8 + 7,2 - 36 = 0\,.$$

Results are approved by Kirchhoff´s laws.

Řešení obvodů stejnosměrného proudu s jedním zdrojem - DC circuits with a single source - slovníček odborných termínů

Vocabulary	Slovníček
apply	platit, používat
approve	ověřit
auxiliary	pomocný
calculate	vypočítat
circuit	obvod
connect , connection	zapojit, zapojení
current DC	proud, stejnosměrný
derive	odvodit, vypočítat
DC (voltage, circuit)	stejnosměrný
flow , the current flows	téci
in series	za sebou, seriově
initial	počáteční, původní
Kirchhoff´s Law	Kirchhoffův zákon
load	zátěž
loop	smyčka
node	uzel
note	poznámka
Ohm´s Law	Ohmův zákon
parallel	paralelní, vedle sebe
resistence, resistor	odpor
resistive	odporový
simplify	zjednodušit
source	zdroj
substitude	nahradit
value	hodnota
voltage	napětí

Zdroj:
ROUBALOVÁ, J., *Elektrotechnika* [online]. [cit. 2014-10-20]. Dostupné z WWW: <http://www.spstr.pilsedu.cz/osobnistranky/j_roubalova/ele.html>