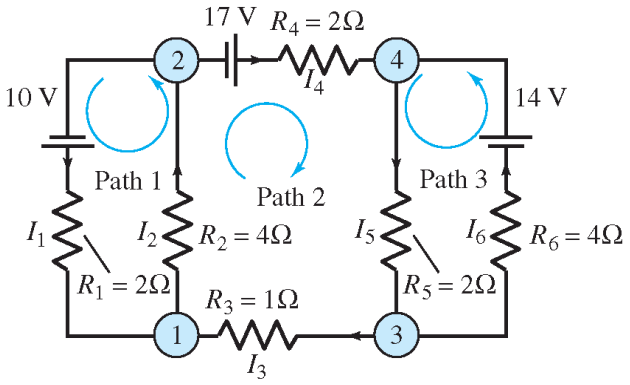
Oct 2022

Individual Assignment: Equation system

The figure to the right shows an electric circuit, with three power sources and six resistors. There are four nodes (numbered 1-4) and three paths. Your task is to find the electric currents I_1 - I_6.



The linear equation system to the right can be used to solve the problem. The equation system has six unknowns I_1-I_6, and you get the sought-after solution by solving it.
The numbers 10, 17 and 14 in the right-hand-side is the voltage in the three power sources.

How the equation system is derived can be found on next page (you do not need it for solving the problem though).

$$\begin{cases} 6I_2 - 2I_3 = 10 \\ 4I_2 + I_3 + 2I_4 + 2I_5 = 17 \\ 2I_5 + 4I_6 = 14 \\ I_1 - I_2 + I_4 = 0 \\ I_3 - I_5 + I_6 = 0 \\ I_4 - I_5 + I_6 = 0 \end{cases}$$

To do

Write a Python script that computes the currents I_1-I_6 (i.e. solve the equation system) and present the currents in a bar graph. On the x-axis is the nodes 1, 2, …, 6, and on the y-axis the corresponding current.
Use the content in lab 1 when you solve it, and try to use "good" Python commands in your coding. Write the script so that it is easy to change the voltages (10,1 7 and 14).
When the program works, change the voltage in one or a couple of the power sources, for example from 17V to 100V and run the program again. Note that negative currents are allowed, meaning that the direction of the current is opposite the arrows.

Hand in the code and the graph in a pdf-file in Studium. Note, it's perfectly fine to hand in a not-so-good code. You will get feedback on your solutions, and also opportunity to improve it.

Rules

- It is mandatory to hand in the Individual lab assignment in due time
- Must be solved *individually*
- Solved *after the corresponding lab session* (at home or in computer lab).
- It is essential that you *try* to solve the problem, not that you solve it correctly. If you don't know how and what to do, hand in what you have (even if it is just a few rows of code). The task will be approved even with an incorrect or even empty solution, and you will get feedback and opportunity to improve it.
- The task is linked to a computer lab. Thus, you can look back into the lab and find out how to solve the problem.

Where does the equation system come from?

You don't need this to solve the assignment, but it might interesting anyway to understand where the equation system comes from. To derive the equation system, we use
1) *Ohm's law*, *U=RI* (in the resistors), where *U* is the voltage drop in the resistor
2) *Kirchoffs 1st law*, the sum of the currents arriving at a node is equal to the sum of the currents leaving the node.
3) *Kirchoffs 2nd law*, the voltages in a closed-circuit loop are equal to 0.

In the three circuits, path 1-3, the law 3) together with law 1) gives equation (1) to (3)

$$\begin{cases} 2I_1 + 4I_2 = 10 & (1) \\ 4I_2 + I_3 + 2I_4 + 2I_5 = 17 & (2) \\ 2I_5 + 4I_6 = 14 & (3) \end{cases}$$

In the nodes 1- 4, law 2) yields equation (4) to (7)

$$\begin{cases} I_1 + I_3 = I_2 & (4) \\ I_1 + I_4 = I_2 & (5) \\ I_3 + I_6 = I_5 & (6) \\ I_4 + I_6 = I_5 & (7) \end{cases}$$

Combine these two and you get an equation system with 7 equations and 6 unknowns. We can eliminate one equation, for example by solving for I_1 in equation (4) and plug into equation (1). That will lead to the equation system on previous page.