# LABORATORY EXERCISE 1
## Basic laws in electric circuits

**Goal of the lab:** The goal of this lab is to demonstrate to the students the basic laws in DC electrical circuits and to teach them to use the laboratory equipment.

## 1.    Required equipment

| Equipment | Count |
|---|---|
| Breadboard | 1 pc. |
| A set of connecting wires | 1 pc. |
| DC power supply | 1 pc. |
| Multimeter | 1 pc. |
| Resistor 10 Ω, 5 W | 1 pc. |
| Resistor 47 Ω, 5 W | 1 pc. |
| Resistor 100 Ω, 5 W | 1 pc. |
| Resistor 150 Ω, 5 W | 1 pc. |
| Cable Banana-Pin | 6 pcs. |
| Cable Banana-Banana | 2 pcs. |

## 2.    Tasks

**Task 1.** For the circuit in fig. 1, verify the Kirchoff's current law (KCL) and the conservation of power.



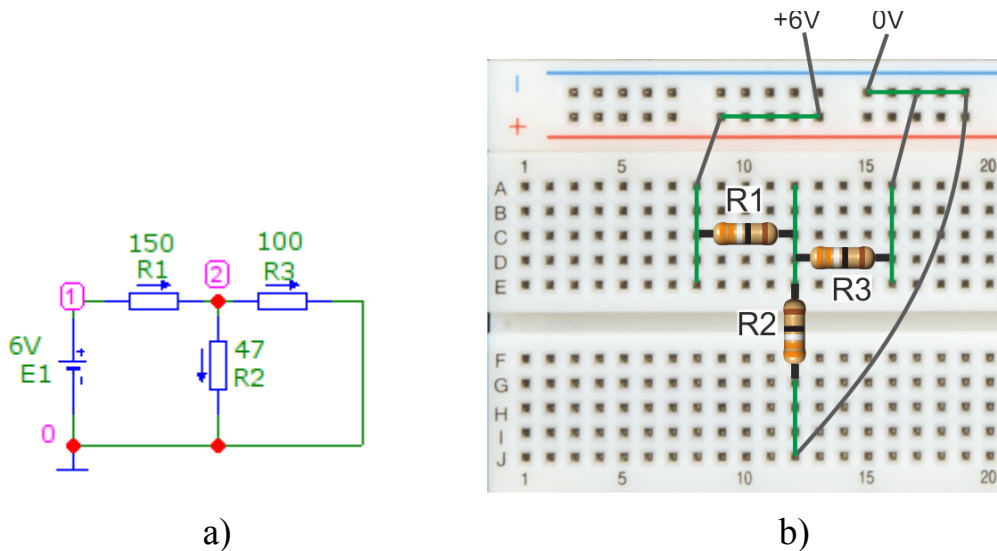a)                                                          b)

Fig. 1.

**Step 1.** Connect the circuit from fig. 1a (this could be done as shown on fig. 1b) on the breadboard. Supply the circuit with 6V from the DC power supply.

**Step 2.** Switch the multimeter to measure DC voltage with range 20 V. Connect the COM probe of the multimeter to Node 0 (marked as ground). Then using the

second probe, measure the node voltages of the other nodes (marked as 1 and 2): $U_{N1}$ and $U_{N2}$ .

**Step 3.** Estimate the currents in the circuit using Ohm's law:

$$I_1 = \frac{U_{N1} - U_{N2}}{R_1}$$

$$I_2 = \frac{U_{N2} - U_{N0}}{R_2}$$

$$I_3 = \frac{U_{N2} - U_{N0}}{R_3}$$

**Step 4.** Write down the KCL for one of the two nodes:

$$I_1 = I_2 + I_3$$

Substitute the currents from Step 3 and verify the law.

**Step 5.** Estimate the powers of the voltage source and of the resistors:

$$P_{E1} = (U_{N1} - U_{N0}).I_1$$

$$P_{R1} = I_1^2.R_1$$

$$P_{R2} = I_2^2.R_2$$

$$P_{R3} = I_3^2.R_3$$

- Write down the conservation of power equation with letters:

$$P_{E1} = P_{R1} + P_{R2} + P_{R3}$$

- Substitute the powers and verify the conservation of power.

**Task 2.** For the circuit in fig. 2, verify the Kirchoff's voltage low (KVL).



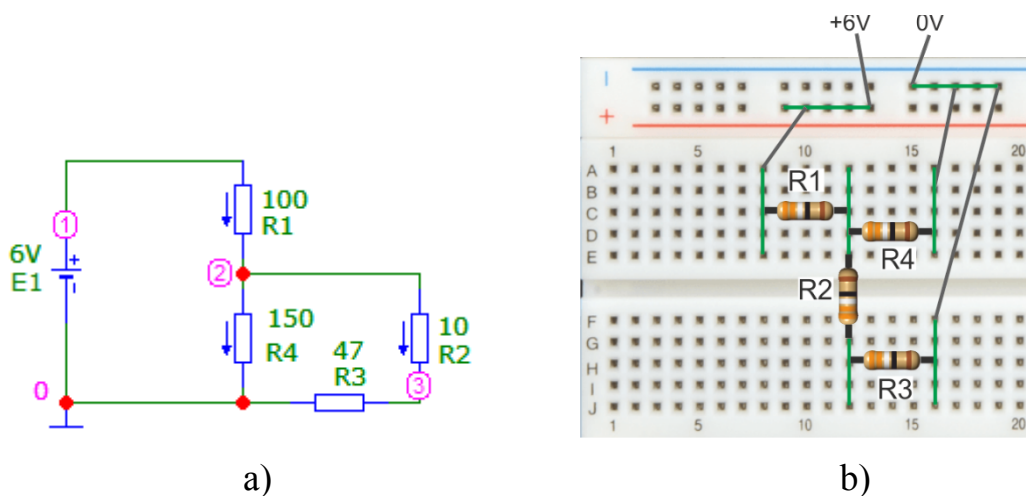a)                                                          b)

Fig. 2.

**Step 1.** Connect the circuit from fig. 2a (this could be done as shown in fig. 2b) on the breadboard. Supply the circuit with 6 V from the DC power supply.

***Step 2.*** Switch the multimeter to measure DC voltage with range 20 V. Connect the COM probe to node 0 and with the second probe measure the node voltages of the other nodes (marked as 1, 2 and 3): $U_{N1}$ , $U_{N2}$ and $U_{N3}$ .

***Step 3.*** Estimate the voltage of the source and the voltage drops on the resistors:

$$E_1 = U_{N1} - U_{N0}$$

$$U_{R1} = U_{N1} - U_{N2}$$

$$U_{R2} = U_{N2} - U_{N3}$$

$$U_{R3} = U_{B3} - U_{B0}$$

$$U_{R4} = U_{N2} - U_{N0}$$

***Step 4.*** On your circuit schematics mark the three possible loops and write down three KVL equations for them:

$$E_1 = U_{R1} + U_{R4}$$

$$E_1 = U_{R1} + U_{R2} + U_{R3}$$

$$0 = U_{R2} + U_{R3} - U_{R4}$$

Substitute the obtained voltages from Step 3 and verify the equations.

## 3. Questions

1. Do the numbers in KCL, KVL and conservation of power equations match perfectly? Why?

2. Using the node voltages from Task 1, how could the voltage drops on the resistors be obtained?

3. Using the node voltages from Task 2, how could the branch currents be obtained?