Week 5. Kirchhoff's Laws

Introduction

Electrical circuits often require calculations to be made in order to choose voltages, currents or resistances. It is therefore logical to learn to draw up formulas, instead of hoping that you will find the right formula on the Internet. The basis for drawing up formulas are Kirchhoff's laws. The law that says that the sum of the voltages in a mesh is zero will be checked using a few different circuits. The other law says that the sum of the currents in a node is zero.

PREPARATION

Before you can carry out this weekly assignment, you must have prepared this assignment before the start of the lesson. This means that you read the following carefully and find out any ignorances and make them your own. This way you can finish this assignment within the time limit to avoid falling behind.

Goals

1. Using the reference direction of voltage and current
2. Verifying Kirchhoff's Laws
3. Drawing up comparisons for electrical networks
4. Creating formulas for electrical networks

Language

Node:	node.
Mesh:	a closed loop in an electrical circuit.
Verification:	check whether something is correct.
Unloaded:	Nothing connected to it, or something connected to it that has no influence whatsoever.

Current flows <u>through</u> a resistor. Voltage stands <u>over</u> a resistor

Safety

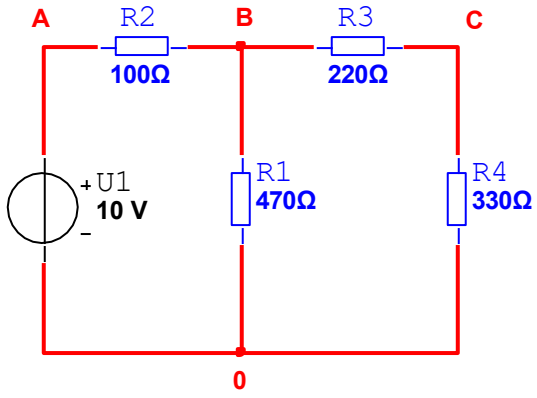
The same safety provisions apply to all laboratories. These provisions are posted in every laboratory and every student must know these provisions.
Point: Measurement setups may only be assembled, modified or disassembled when de-energized.

1. Practical implementation

1.1 Kirchhoff - The sum of the voltage in a mesh is zero

1-source, 2-mesh network.

a. Build this network. Set the voltage source exactly (10.00 V).



b. Measure in the meshes with a Metrahit 29S multimeter and note the voltages you measure. **UXY** means that the **positive** probe of the meter **is connected** to point X and the negative **pin is connected to point** Y.
When reading the meter, pay close attention to whether the voltage has a positive or negative sign. Calculate the absolute error based on the formula: ΔU = 0.1% rdg + 5d

	meet-value ()	Abs. error()
UAB		
UB0		
U0A		
sum		

	meet-value ()	Abs. error()
U0C		
UCB		
UB0		
sum		

c. Can you say that the sum of the voltage for both meshes is zero? Why can you say that or not? (think of the value of the measurement error!). Measure again if not.

Network with 2 sources and 2 meshes.

d. Replace R4 with a 3-cell battery of 6 Volt. Make a complete drawing of this network.

e. Measure all voltages again and put them in a table like the one above.

Calculate the absolute error based on the formula: ΔU = 0.1% rdg + 5d

	Measured value ()	abs. error ()
UAB		
UB0		
U0A		

	Measured value ()	abs. error ()
U0C		
UCB		
UB0		

f. Can you again say that the sum of the voltage for both loopholes is zero? Why can you say that or not? Measure again if not.

g. Look at the polarity definition in your diagram and at the measurements. Now, without measuring the current, give an answer: how can you tell if the battery is being charged or discharged?

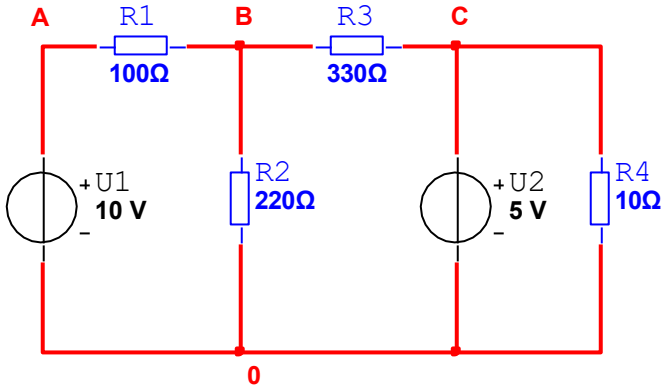
h. Set up the voltage equations (KVL) for the two meshes. (the sum of voltages = 0)
From this equation, bring the voltage UB0 to the fore and then calculate the voltage U_{B0} by entering the measured values.
Is it true?

1.2 Kirchhoff - The sum of the currents in a node is zero

Dual-source network

a. Build this measuring circuit: First, set the voltage sources U1 and U2 exactly. (10.00 Volts and 5.00 Volts)

   R4 is needed for the circuit to work properly, at the end of the test you will understand why.
   It also shows that there can be multiple circuits, and we only have to focus on one part.



b. In the measuring circuit is node B. Disconnect 1 connection at a time and connect the digital multimeter as an ampmeter in series, as explained below. Use a Metrahit 29S as an ammeter. Measure the following flows in Node B:
   Calculate the absolute error based on the formula: ΔI = 0.1% rdg + 5d

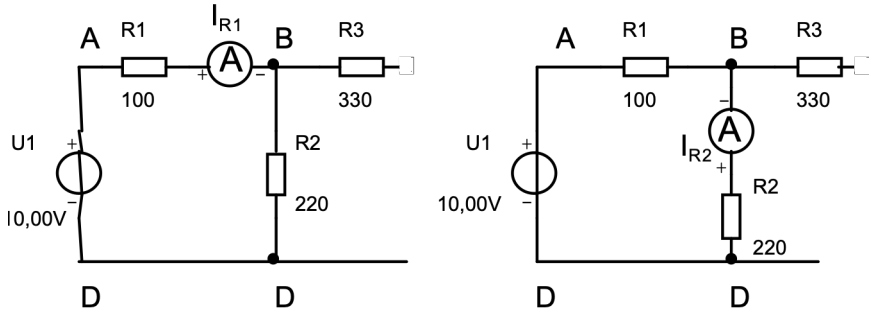
	Measured value (mA)	Abs. error ()
IR1		
IR2		
IR3		
sum		

Assumption: the positive current goes to point B, so:
Always connect the pin to point B

EXAMPLE (U1 and U2 always both connected)

Example of the wiring diagram to measure IR1 and I_{R2} .

If you read a negative value, it means that the current is actually flowing in the opposite direction.



c. Can you say that the sum of the currents for node B is zero? Why can you say that or not? Think again of the outcome of the error calculation.

d. If the sum is not zero, explain why. Also give your statement directly to the teacher.