KVL and KCL rules govern every lumped electrical circuit regardless of its elements. In this experiment, you practically verify KCL and KVL rules.

MANDATORY EXPERIMENTS

Experiment 1

Build the circuit shown in Fig. 1 on a breadboard.

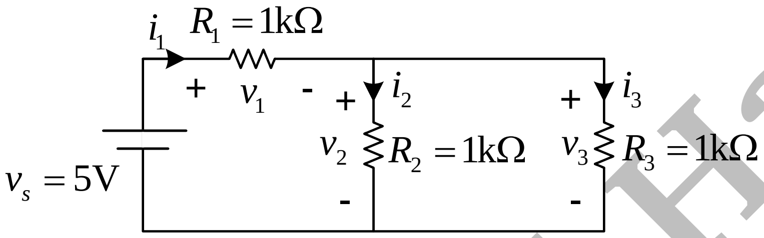

Figure 1: A resistive circuit.

(a) Measure the voltages of the circuit using a multimeter and verify the KVL $v_s = v_1 + v_2$.

(b) Measure the currents of the circuit indirectly using a multimeter and verify the KCL $i_1 = i_2 + i_3$.

(c) Reverse the direction of the current i_2 *and the polarity of the voltage* v_3 *in Fig. 1 and repeat the previous parts.*

(d) Change the resistors to $10\ k\Omega$ *and repeat the previous parts.*

Experiment 2

Build the circuit shown in Fig. 2 on a breadboard and use two oscilloscopes to show the marked voltages. Use external triggering to synchronize the two oscilloscopes.

Experiment 2 continued on next page...

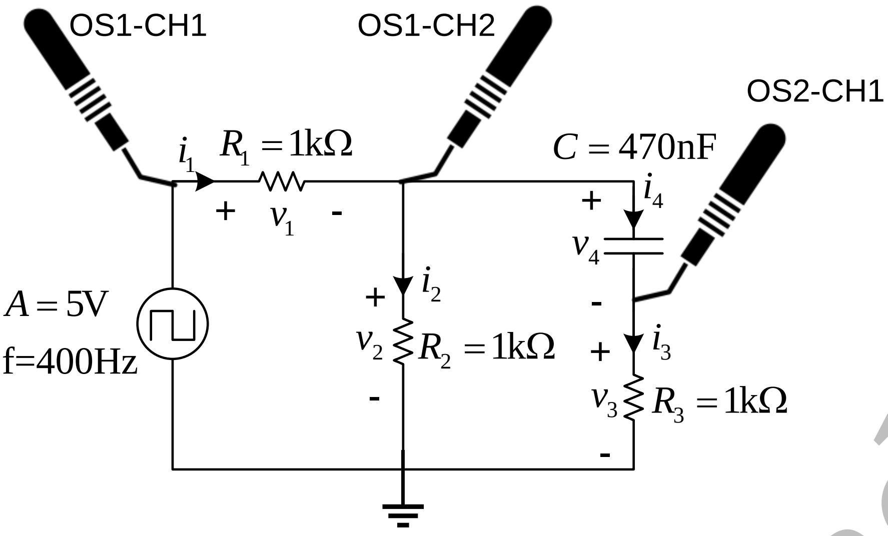

Figure 2: A sample circuit.

(a) Verify the KCL $i_1 = i_2 + i_4$ graphically using the oscilloscopes.

(b) Change the square wave to sine wave and repeat the previous part.

(c) Redo the previous parts when the capacitor is replaced with a diode.

BONUS EXPERIMENTS

Experiment 3

Write a MATLAB/Python code that receives the data set $(x_i, y_i), i = 1, \cdots, n$ and determines the optimal coefficients of the linear curve $y = ax + b$ that fits the data set with the least square error $\epsilon = \sum_{i=1}^{n}(y_i - ax_i - b)^2$.

Experiment 4

Tab. 1 includes the measured voltage and current pairs for an unknown LTI resistor. Use linear curve fitting to estimate the characteristic curve of the resistor and its resistance.

Voltage (V)	02.03	04.12	06.25	08.65	10.00	14.26	16.76	17.56	19.75	21.28
Current (mA)	00.97	01.90	03.18	03.94	05.41	05.61	06.66	07.43	08.34	10.73
Voltage (V)	26.13	25.70	26.37	32.52	32.27	33.38	36.68	36.40	38.72	47.89
Current (mA)	11.17	12.11	12.07	14.98	15.36	15.52	17.04	17.64	17.38	18.95

Table 1: Measured voltages and currents for an LTI resistor.

Experiment 5

Return your work report by filling the LaTeXtemplate of the manual. Include useful and high-quality images to make the report more readable and understandable.