CDE laboratory_01

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LaTeX

1 Verification of Kirchhoff and Ohm's laws for electrical circuits.

Kirchhoff first law: The current entering any junction is equal to the current leaving that junction.
Kirchhoff second law: The sum of all the voltages around a loop is equal to zero.

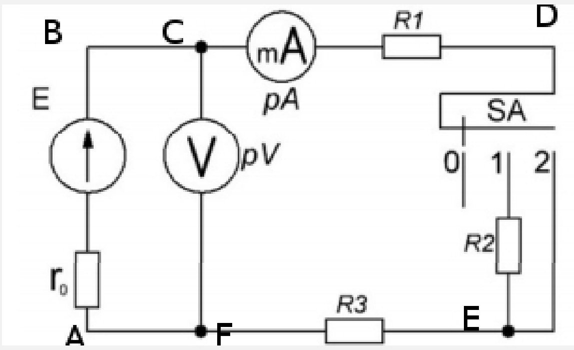

Figure 1: Circuit 1.1

1.1

$R_1(\Omega)$	$R_2(\Omega)$	$R_3(\Omega)$	$I_1(mA)$	$I_2(mA)$	$U_{t1}(V)$	$U_{t2}(V)$
99.8	198	53.7	42.1	96.0	15.01	15.01

1.2

Internal resistance:

$$r_0 = \frac{U_{t2} - U_{t1}}{I_1 - I_2} = \frac{0}{I_1 - I_2} = 0$$

The tools we had, weren't exact enough, that's why we got $r_0 = 0$. To find a more exact value of internal resistance, we need something better.

1.3

The current in circuit and the tensions in each resistance by the Ohm's Laws.

$$I = \frac{E}{R_1 + R_2 + R_3 + r_0} = \frac{15}{351.5} = 42.67\ mA$$

$$U_1 = IR_1 = 42.67 \cdot 99.8 = 4.26\ V$$

$$U_2 = IR_2 = 42.67 \cdot 198 = 8.45\ V$$

$$U_3 = IR_3 = 42.67 \cdot 53.7 = 2.29\ V$$

1.4

R (Ω)		I_c(mA)	U_c (V)		I_m (mA)	U_m (V)	
R_1	99.8	42.67	U_1	4.26	42.1	U_1	4.24
R_2	198		U_2	8.45		U_2	8.43
R_3	53.7		U_3	2.29		U_3	2.26

1.5 Verify the second Kirchhoff's law

$$U_{c1} + U_{c2} + U_{c3} = 4.26 + 8.45 + 2.29 = \mathbf{15\ V}$$

$$U_{m1} + U_{m2} + U_{m3} = 4.24 + 8.43 + 2.26 = \mathbf{14.93\ V}$$

1.6

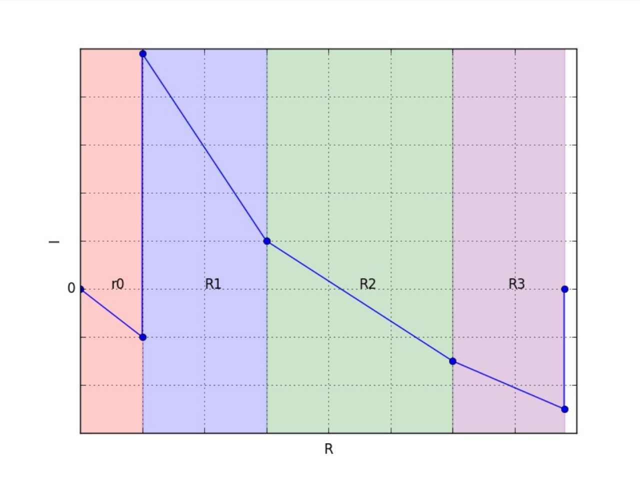

Figure 2: Potential Chart of Circuit 1

1.7 Verify the first law of Kirchhoff

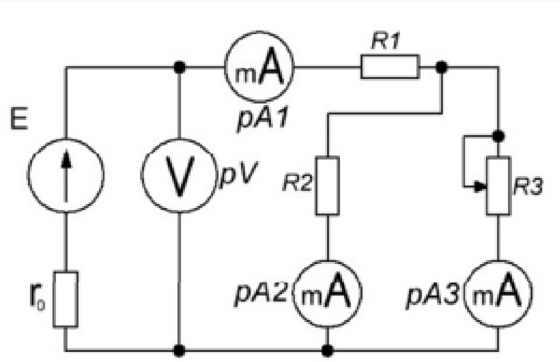

Figure 3: Circuit 1.2

The equivalent resistance of the circuit R_E:

$$R_E = R_1 + \frac{R_2R_3}{R_2+R_3} = 99.8 + \frac{198 \cdot 473}{198+473} = 239.37\ \Omega$$

$$I_1 = \frac{E}{r_0 + R_E} = \frac{15}{0 + 239.37} = 62.66\ mA$$

$$U_2 = U_3 = I_1\frac{R_2R_3}{R_2+R_3} = 62.66 \cdot \frac{198 \cdot 473}{198+473} = 8.75\ V$$

$$U_1 = I_1 \cdot R_1 = 61.7 \cdot 99.8 = 6.16\ V$$

$$I_2 = \frac{U_2}{R_2} = \frac{8.75}{198} = 44.19\ mA \ \Big|\ I_3 = \frac{U_3}{R_3} = \frac{8.75}{473} = 18.50\ mA$$

R (Ω)		$I_c(mA)$		$U_c(V)$		$I_m(mA)$		$U_m(V)$	
R_1	99.8	I_1	62.66	U_1	6.16	I_1	61.7	U_1	6.66
R_2	198	I_2	44.19	U_2	8.75	I_2	43.2	U_2	8.69
R_3	473	I_3	18.50	U_3	8.75	I_3	18.6	U_3	8.69

1.8

Kirchhoff's first Law

$$\sum_{1}^{n} I_k = 0 \Rightarrow I_2 + I_3 - I_1 = 0 \Rightarrow 43.2 + 18.6 - 61.7 = 0.10 \approx 0$$

Power Balance

$$E \cdot I_1 = I_1^2(r_0 + R_1) + I_2^2 R_2 + I_3^2 R_3 \Rightarrow$$

$$15 \cdot 61.7 = \frac{1}{10^3} \cdot (61.7^2 \cdot (0 + 99.8) + 43.2^2 \cdot 198 + 18.6^2 \cdot 473) \Leftrightarrow$$

$$925.50\ W \approx 913.08\ W$$

1.9

Measured							Calculated		
R_3	U	U_1	U_2	I_1	I_2	I_3	$U_1 + U_2$	$I_2 + I_3$	P
Ω	V			mA			V	mA	mW
0	15	14.93	0.06	144.3	0.2	143.5	14.99	143.7	2164.5
100		9.06	5.88	88.4	29.4	59.2	14.94	88.6	1326
200		7.57	7.42	74	37.1	36.7	14.99	73.8	1110
300		6.9	8.0	67.2	40.5	26.7	14.9	67.2	1008
467		6.35	8.64	62	43.3	18.6	14.99	61.9	930

$$P_{R_3} = U \cdot I_{R_3}$$

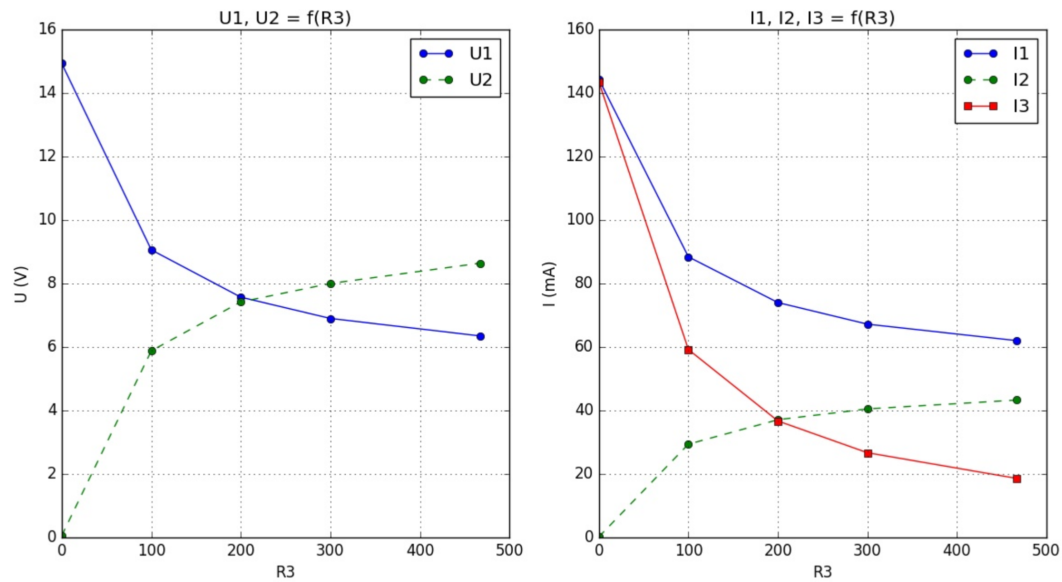

Figure 4

1.10 Conclusion

In this laboratory work we showed that the Kirchhoff's laws are true, by making our own circuits. The errors appeared mostly because of the human factor and because of the relatively bad equipment.
In the first graph is shown the second Kirchhoff's law: $U_1 + U_2 = 15V$
From the second graph, we can clearly see the first Kirchhoff's Law: $I_1 = I_2 + I_3$.

2 De cercetat proprietatile elementelor pasive (R, L, C) în circuitul de curent alternativ.

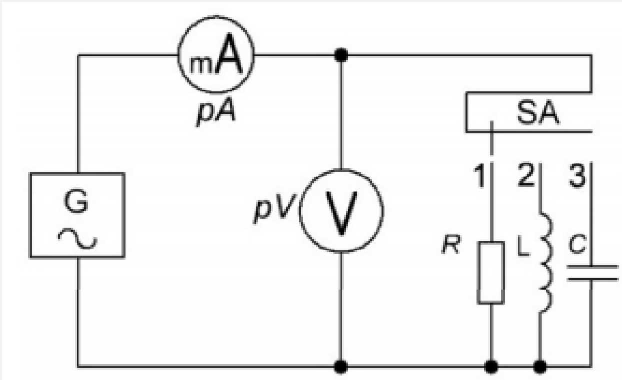

Figure 5: Circuit 2.1

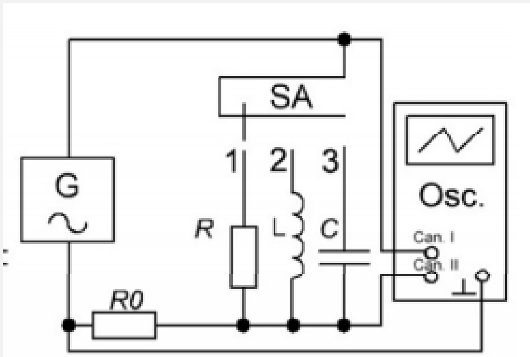

Figure 6: Circuit 2.2

Element	U	U_m	I	I_m	ϕ	Q	S	P	R	C	L	X_C	X_L
	V		mA		o	VAR	VA	W	Ω	nF	mH	Ω	Ω
$R = 510\Omega$	10.3		20										
C = 56 nF	4.43		186.3										
L = 3.64 mH	11.34		510										

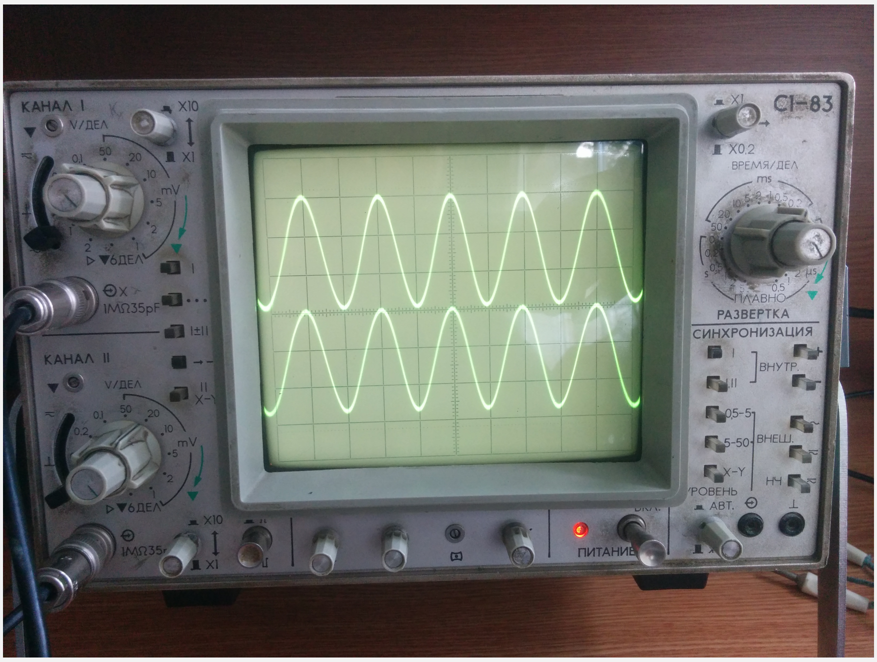

Figure 7: Oscilograph pos 1

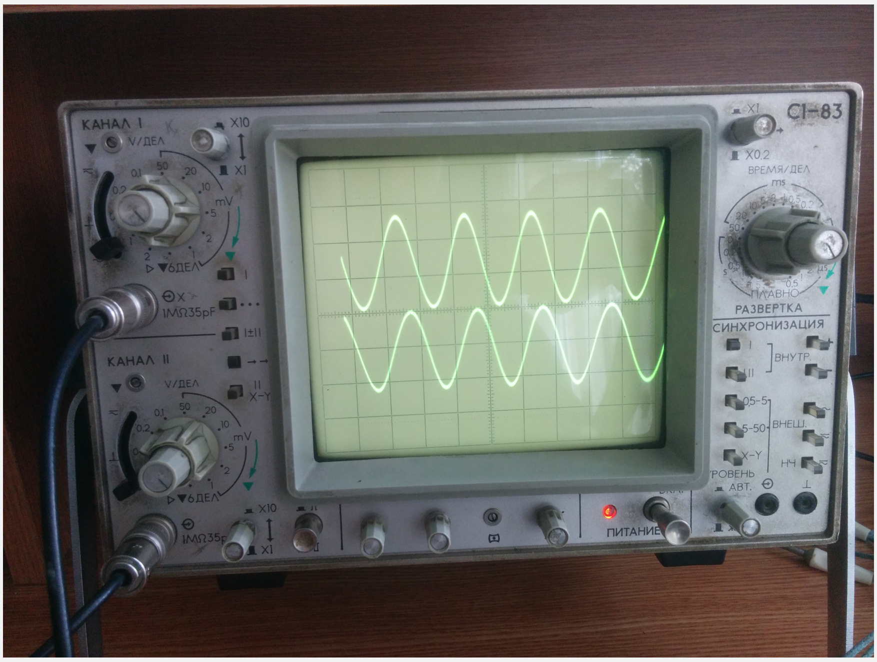

Figure 8: Oscilograph pos 2

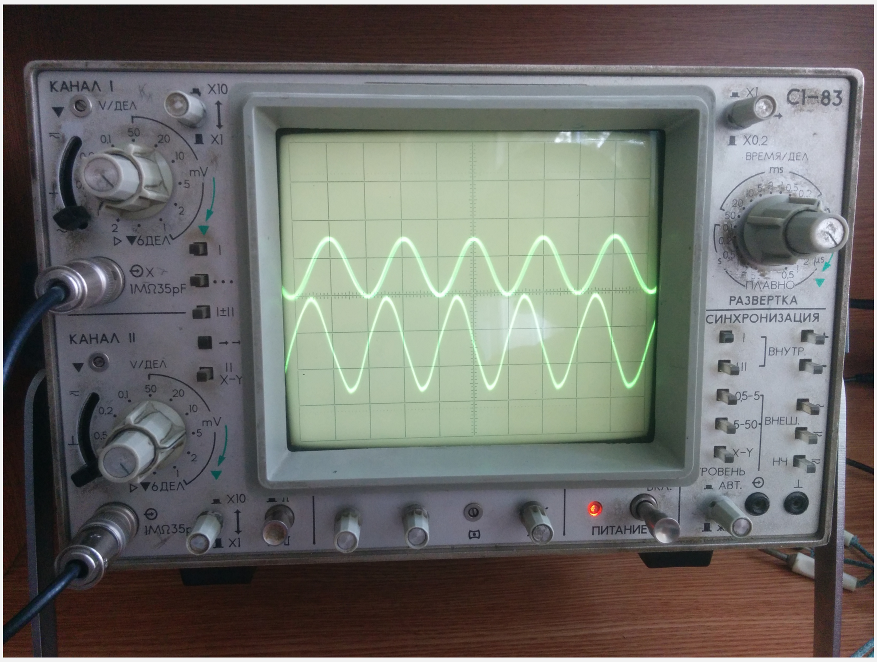

Figure 9: Oscilograph pos 3