MARITIME UNIVERSITY OF SZCZECIN

ORGANIZATIONAL UNIT:
DEPARTMENT OF MARINE COMMUNICATION TECHNOLOGIES

INSTRUCTION

ELECTRICAL ENGEENERING AND ELECTRONICS
Laboratory
Exercise No 2: RLC circuits

The second option

Prepared by:	dr inż. Marcin Mąka, dr inż. Piotr Majzner
Approved by:	dr inż. Piotr Majzner
Is valid from: 25. IX 2017	

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2. RLC circuits

2.1. The purpose and scope of the exercise

The aim of the exercise is to master knowledge in the field of construction and application of basic electrical circuits including differentiating and integrating systems as well as series and parallel resonance systems.

Issues:

1. Basic electrical components.
2. Basic laws of the theory of electric circuits.
3. Principles of performing measurements with an oscilloscope.
4. Structure, characteristics and basic relationships of differentiating systems.
5. Structure, characteristics and basic relationships of integral circuits.
6. The use of differentiating and integrating systems.
7. Structure, characteristics and basic dependencies of the serial resonant circuit.
8. Structure, characteristics and basic relations of a parallel resonant circuit.
9. The use of resonant circuits.

Control questions

1. Discuss the construction, operation and use of differentiating systems.
2. Discuss the construction, operation and use of integrating circuits.
3. Describe the phenomenon of series resonance.
4. Describe the phenomenon of parallel resonance.
5. What is the frequency characteristics?
6. What is the bandwidth of the resonance circuit (characteristics)?
7. What is the effect of Q-factor on the shape of the frequency response?
8. Give the basic relations regarding the resonant circuit series.
9. Give the basic relations regarding the parallel resonant circuit.

2.2. Description of the measurement system

A set of instruments:

1. A generator of sinusoidal waveforms.
2. Two-channel oscilloscope.
3. Connection board.
4. Adjustable resistor.
5. Adjustable capacitor.
6. Adjustable inductance.

The **RLC WARIANT II** circuit board is universal. It is used for assembly of both resonant systems: serial and parallel with the use of the above-mentioned elements. A sinusoidal signal from the generator is connected to the " U_{we} " terminals. The oscilloscope is connected to the " U_{wy} " terminals. The current flowing in the circuit is observed by the voltage drop across the measuring resistor R_p that has no significant effect on the circuit's operation.

2.3. The course of the exercise

2.3.1. Serial resonance measurements

On the board for "Testing of RLC circuits and oscilloscope measurements" connect::

- generator - for the serial resonance input (sockets U_{we}),
- an oscilloscope for the serial resonance output (sockets U_{wy}),
- for the sockets marked *R*, *L*, *C* in figure 1 respectively: adjustable resistor, adjustable capacitor, adjustable inductance,
- jumpers - to the sockets marked ZW in the Figure 1,
- measuring resistor **R_p = 10 Ω** - to the sockets marked R_p in the Figure 1,

The connected circuit is shown in Figure 2.

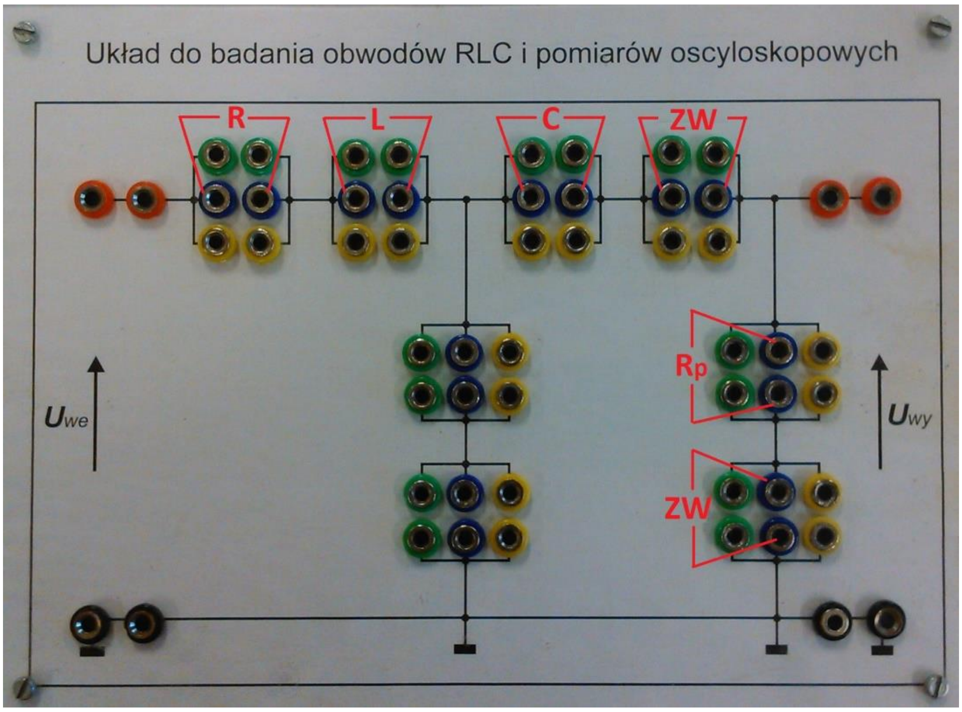


Fig. 1. Measurement system for series resonance testing

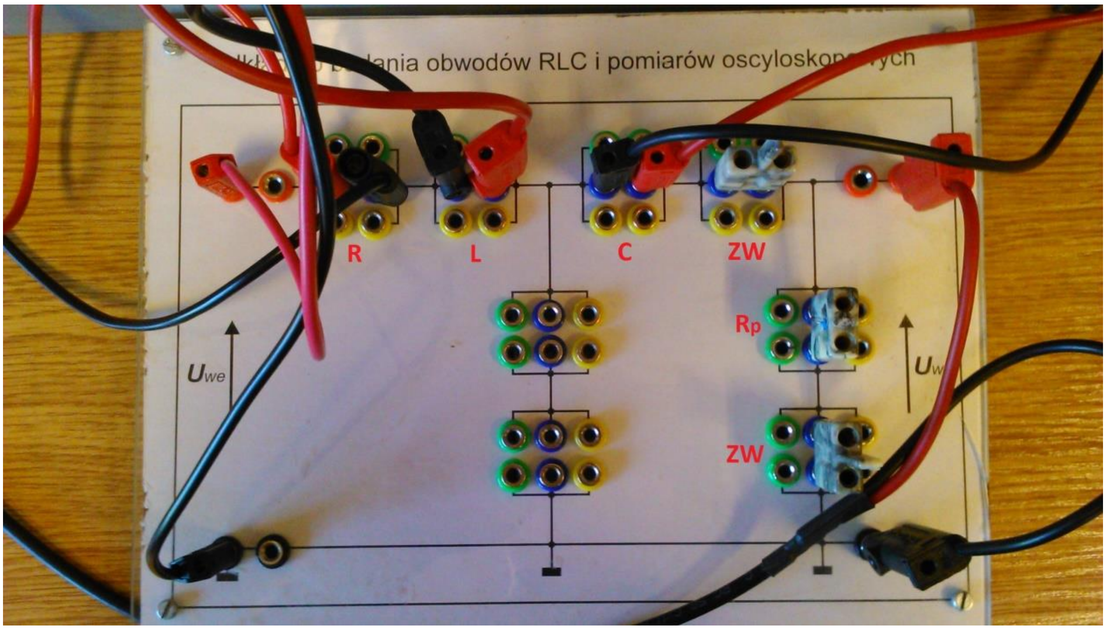


Fig.2. Connected measurement system for series resonance testing

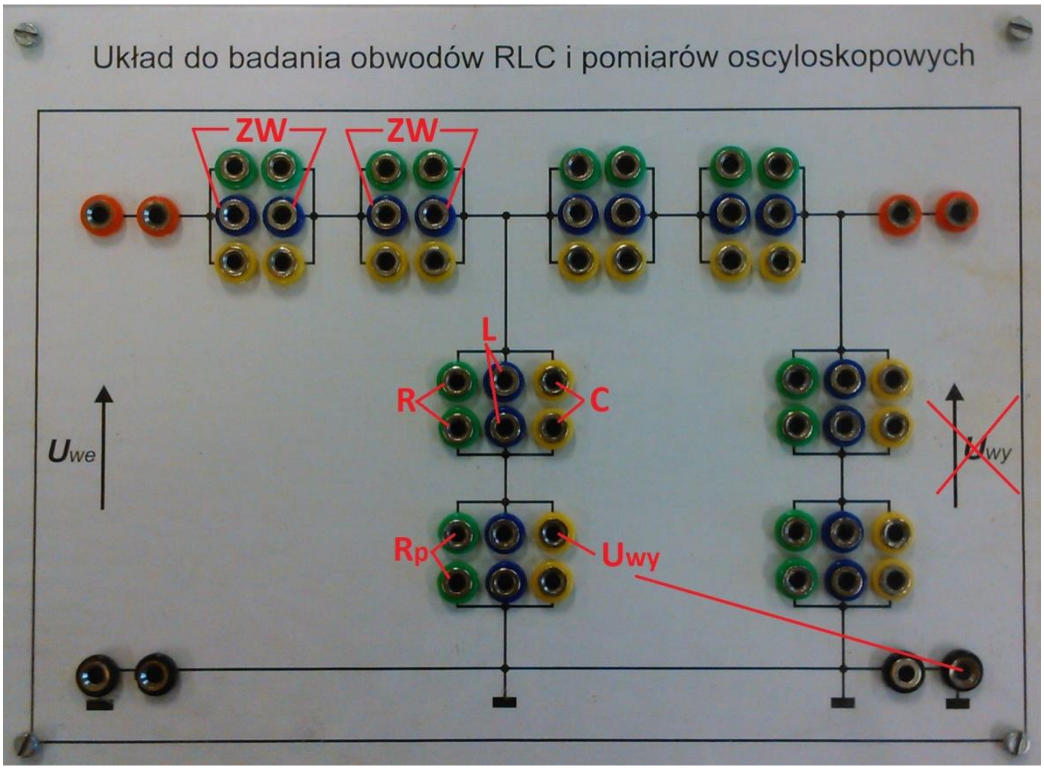
1. Set the initial values of the *R*, *L*, *C* elements:
   - ***R*= 0 Ω** - set all knobs to value **0**,
   - ***L* = 0,7 H** – knob **x0,1H** set to value **7**, all others set to **0**,
   - ***C* = 500 pF** - knob **x0,0001** set to value **5**, all others set to **0**,

NOTE: On the measurement card for both circuits: serial and parallel, the value of capacity for the exercise in option I is given. Please correct the value of the capacity C_1 on the measurement card on C_1 = 500 pF !!!

2. Add a sinusoidal signal with an amplitude of ***U* = 10 V** and frequency ***f* = 1 kHz** to the circuit input.
3. Find the resonant frequency f_{rez} (**the amplitude** of the voltage measured at the output of the circuit **is the largest**) and save it to the table. Measure the three frequency characteristics of the resonant circuit sequentially when three resistance values *R* are connected in the sequence. Measurements should be made around the resonant frequency with the step given on the measurement card:
   - ***R* = 0 Ω** - set all knobs to value **0**, all others set to **0**,
   - ***R* = 330 Ω** - knob **x100** set to value **3**, knob **x10** set to value **3**, all others set to **0**,
   - ***R* = 3 kΩ** - knob **x1k** set to value **3**, all others set to **0**,
4. Repeat the measurements described in item 3 for the capacity:
   - ***C* = 1 nF** - knob **x0,001** set to **1**, all others set to **0**,
   - ***C* = 1,5 nF** - knob **x0,001** set to value **1**, knob **x0,0001** to value **5**, all others set to **0**,

2.3.2. Parallel resonance measurements

1. Connect all elements of the parallel resonance circuit as shown in Figure 3.
2. Connect the measuring resistor R_p with the value **R_p = 470 Ω**



Rys. 3. Measurement system for paralel resonance testing

3. Set the initial values of the *R*, *L*, *C* elements:
   - ***R*= 30 kΩ** - knob **x10k** set to value **3**, all others set to **0**,
   - ***L* = 0,7 H** – knob **x0,1H** set to value **7**, all others set to **0**,
   - ***C* = 500 pF** - knob **x0,0001** set to value **5**, all others set to **0**,
4. Add a sinusoidal signal with an amplitude of ***U* = 10 V** and frequency ***f* = 1 kHz** to the circuit input.
5. Find the resonant frequency f_{rez} (**the amplitude** of the voltage measured at the output of the circuit **is the lowest**) and save it to the table. Measure the three frequency characteristics of the resonant circuit sequentially when three resistance values *R* are connected in the sequence. Measurements should be made around the resonant frequency with the step given on the measurement card:
   - ***R* = 30 kΩ** - knob **x10k** set to value **3**, all others set to **0**,
   - ***R* = 60 kΩ** - knob **x10k** set to value **6**, all others set to **0**,
   - ***R* = 100 kΩ** - knob **x10k** set to value **10**, all others set to **0**,

NOTE: On the measurement card for the parallel circuit, the resistance values R_1, R_2, R_3 are given for the exercise in option I. Please correct the resistance values on the measuring card !!!

6. Repeat the measurements described in point 4 for the capacity:
   - C = 1 nF - knob **x0,001** set to value **1**, all others set to **0**,
   - C = 1,5 nF - knob **x0,001** set to value **1**, knob **x0,0001** set to value **5**, all others set to **0**,

2.4. Conditions for assessment of the exercise

The condition for assessment of the exercise is:

- to write a short test at the beginning of the class with a positive result;
- to do the exercise;
- preparing a report according to the instructions below;
- positive assessment of the report on the next class;

The report should include:

- a measuring card with calculated currents assuming that the measuring resistor R_p in the series resonance system is 10 Ω and in the parallel resonance system R_p = 470 Ω;
- characteristics of current as a function of frequency for series resonance systems with marked frequency f_d and f_g of the bandwidth;
- characteristics of current as a function of frequency for parallel resonance;
- calculated Q-factors (goodness -*dobroć* in Polish), according to equation:

$$Q = \frac{f_{rez}}{B}$$

- calculated inductance *L*, according to equation :

$$L = \frac{1}{4 \cdot \pi^2 \cdot f_{rez}^2 \cdot C}$$

- own conclusions and observations.

2.5. Theoretical part

The theoretical part is the same as in the first exercise variant