Task
"Verifying Ohm's law in an alternating-current circuit and determination of inductivity and capacity"

Task 1. Determination of inductivity.

Generator of harmonic oscillations ("GZ-118") is connected to the terminal labelled "∼V" in all circuits (Fig. 1). Set the generator output amplitude to the maximal value. The voltmeter "V" and milliammeter "mA" (or suitable multimeters) should be switched to the corresponding measuring regime (Fig. 2). The circuits can be modified by setting and removing jumpers on/from pin contacts labelled JP1–JP3. The jumper (a piece of conductor in plastic insulation) closes up a circuit when it is placed on the pins.

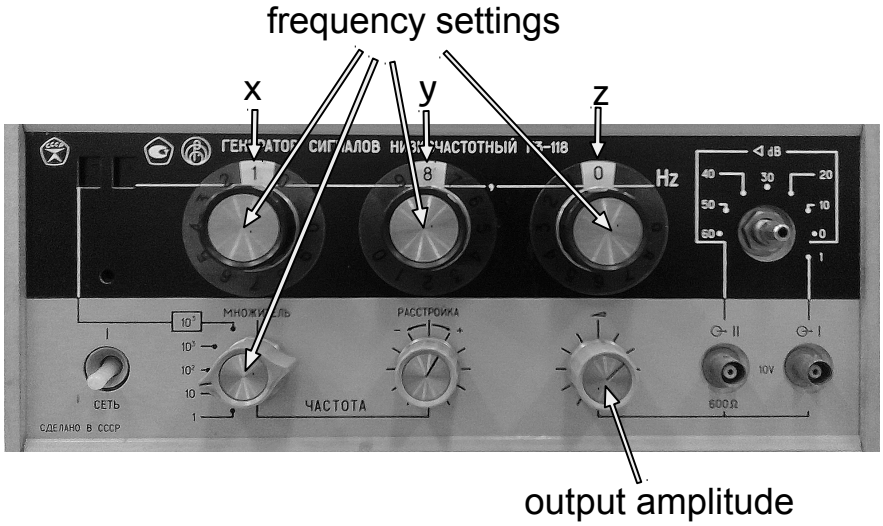
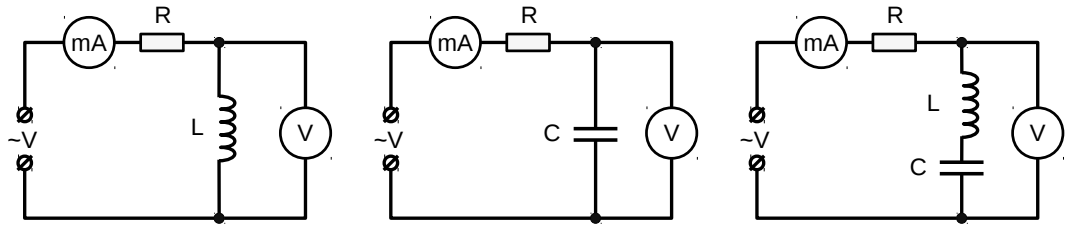


Figure 1: Generator. The produced frequency is derived as $f = (\mathrm{xy.z} \times \mathrm{multiplier})$ Hz. In this picture $f = 18.0 \times 10^2 = 1800$ Hz $= 1.8$ kHz.

1. Assemble the electric circuit according to the scheme in Fig. 2a, where L is a coil with the inductivity L to be measured and a known resistance of $R_0 = 10\,\Omega$, and R is a constant resistance of 220 Ω.

2. Measure and write down the values of the current I_{ief} (amperes) and voltage U_{ief} (volts) at five different values of the frequency produced by the generator (f_i) chosen between 1 and 2 kHz in more or less uniform steps. Rewrite the values f_i as angular frequencies $\omega_i = 2\pi f_i$.



(a) (b) (c)

Figure 2: Connection schemes.

3. For each value of I_{ief} and U_{ief} calculate the impedance of the coil using the formula $Z_{Li} = U_{ief}/I_{ief}$.

4. Calculate the inductivity values using the equation

$$L_i = \frac{\sqrt{Z_{Li}^2 - R_0^2}}{\omega_i},$$

find the mean value L_{av} and estimate the inaccuracy.

5. Find the phase shift angles (in degrees) between the current and voltage as follows:

$$\varphi_i = \arctan\left(\frac{\omega_i L_{av}}{R}\right)$$

Task 2. Determination of capacity.

1. Assemble the electric circuit according to the scheme in Fig. 2b with a capacitor C having an unknown capacity C.

2. Repeat step 2 from task 1. For each measurement I_{ief} и U_{ief} calculate the reactance of the capacitor as $X_{Ci} = U_{ief}/I_{ief}$.

3. Calculate the capacity using the formula

$$C_i = \frac{1}{\omega_i X_{Ci}},$$

find the average C_{av} and estimate the inaccuracy.

Task 3. Verifying the Ohm's law in general form.

1. Assemble the electric circuit according to the scheme in Fig. 2c.

2. Repeat step 2 from task 1. For each measurement I_{ief} и U_{ief} calculate the impedance of the sequential LR_0C-circuit as $Z_{LCi} = U_{ief}/I_{ief}$.

3. Using the values of L_{av} and C_{av} obtained in tasks 1 and 2, find Z'_{LCi} using the theoretical formula $Z'_{LCi} = \sqrt{R_0^2 + (X_{Li} - X_{Ci})^2}$, where $X_{Li} = \omega_i L_{av}$.

4. Compare the value Z_{LCi} with Z'_{LCi} obtained in steps 2 and 3 of this task and approve the Ohm's law for the AC current. In case of discrepancies, explain their possible reasons.

Questions

1. Alternating current. Ways of generating AC. Quasistationary current.
2. Behaviour of a resistor, inductor and capacitor in an AC circuit.
3. Inductive and capacitive reactance. Method of vector diagrams in calculations of AC circuits.
4. Power, amplitude, and effective values of current and voltage.
5. Ohm's law for AC current. Total resistance (impedance) of a circuit. Phase difference between current and voltage.
6. Series resonance.