DEPARTMENT FOR EDUCATION AND SCIENCE OF UKRAINE
NATIONAL TECHNICAL UNIVERSITY
“DNIPRO POLYTECHIC”

PHYSICS.
DETERMINATION OF COIL INDUCTANCE

METHODICAL POINTING TO LABORATORY WORK

for the section “Electrodynamics” of students of all specialties in “Physics” discipline

Dnipro
2018

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Co-autor:
L.I. Bartashevska, A.S. Zaitsev, candidates of Physical and Mathematical sciences.

Approved by the methodical commission for the direction “Mining” (protocol № from) according to presentations of the chair physics (protocol № from).

Methodical materials are necessary for independent preparation of the students for laboratory work and control of the normative discipline “Physics”. The theoretical information, device and installation used considered.

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The recommendations are focused of student’s academic work.

Laboratory work № 3.41

Determination of coil inductance

Devices and accessories: 1. Ammeter; 2. The voltmeter; 3. Rheostat; 4. Inductor coil.
Purpose of the work: 1. studding the phenomenon of self-induction; 2. indicating the inductance of the coil with and without the core.

Description of the method and theoretical information

If an electric current passes through a closed loop, then a certain flux of magnetic induction is attached to this circuit. This flux will change when the magnitude of the current in the circuit changes, as well as when the contour shape and the magnetic permeability of the medium change.

The phenomenon of the appearance of electromotive force in the circuit due to the change in the magnetic flux created by the electric current of this circuit itself is called the phenomenon of self-induction.

The coupled magnetic flux penetrating the area bounded by the current loop is proportional to the magnitude of the current, i.e.,

$$\psi = LI, \qquad (1)$$

where L is the loop inductance.

A quantity that is numerically equal to the magnetic flux through the area of the contour, which characterizes the shape and dimensions of the contour, with a current value of the circuit equal to unity, is called the inductance of the circuit.

If the shape, the contour dimensions do not change, and the contour itself is in a medium whose properties do not depend on the magnetic field, then according to the Faraday-Lenz law, E.D.S. self-inductance is proportional to the rate of change in the magnitude of the current

$$\varepsilon_c = -L\frac{dI}{dt} \qquad (2)$$

This relation makes it possible to determine the inductance L as a coefficient of proportionality between the rate of change in the current strength in the circuit and the resulting EDS self-induction.

The minus sign indicates that E.D.S. self-inductance counteracts a change in the current strength in the circuit - it slows down its increase or decrease. Consequently, the inductance of the circuit is a measure of its inertia with respect to the change in current.

An additional resistance to alternating current is also associated with the inductance of the circuit. This resistance R_L depends on the inductance of the circuit, the frequency of the alternating current and is called the inductive resistance $R_L = L\omega$ ($\omega = 2\pi\,\upsilon$ is the cyclic frequency of the alternating current).

Inductance L of the coil is determined. For this, a method based on measuring the impedance Z of the coil included in the alternating current circuit is applied. The impedance of the coil is expressed in terms of the ohmic and inductive resistances by the formula:

$$Z = \sqrt{R^2 + (L\omega)^2} \qquad (3)$$

From the formula (3) we find

$$L = \frac{1}{\omega}\sqrt{Z^2 - R^2} \qquad (4)$$

The current uses an industrial frequency.

The impedance Z is measured with a voltmeter and an ammeter. Schematic diagram of the laboratory installation is shown in Fig. 1.

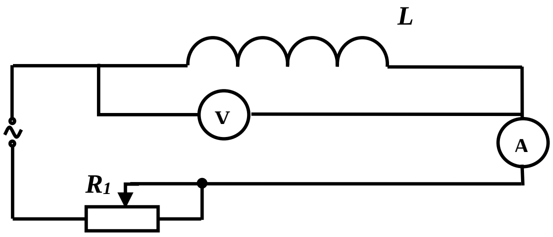

Fig. 1

The rheostat R_1 regulates the current in the circuit, measured by an ammeter, and the voltage drop across the coil is measured by a voltmeter. Using Ohm's law for the chain segment, we get:

$$Z = \frac{U}{I}, \tag{5}$$

where Z is the required impedance of the coil.

Measurements

1. Assemble the electrical circuit as shown in Fig. 1. Switch on the circuit in the network and, changing the resistor by the rheostat, set the voltage or current specified by the teacher, and count the readings of the ammeter and voltmeter. Using formula (5), calculate the impedance of the coil.

Repeat the experiment three times at different voltages or amperages.

The cut-off switch is switched on for the time required to read the instrument readings in one measurement so that the coil does not heat up.

2. Insert the iron core into the coil and repeat the measurements specified in paragraph 1.

3. Calculate the inductance of a coil without a core and with a core according to formula (4). The results of measurements and calculations should be recorded in a table.

Control questions

1. What is the difference between the phenomena of self-induction and electromagnetic induction?

2. What determines the coil inductance?

3. What is the impedance of a coil and what does it depend on?

4. How does the placement of the inside of the core coil from a ferromagnet affect the readings of the measuring devices?

Table of measurement results

№	indicating	I, A	U, B	Z_i, Ohm	R, Ohm	L_i, H	$\langle L_i \rangle$, H	ΔL_i, H	$S_{<L>}$	α	$t_{\alpha,n}$	ΔL, H	E, %
1 2 3	Without a heart												
1 2 3	With the heart												

The final result is written as:

$L_1=(\langle L_1\rangle \pm \Delta L)$ H at $\alpha=\ldots$

$L_2=(\langle L_2\rangle \pm \Delta L)$ H at $\alpha=\ldots$

Literature

1. Kucheruk I.M., Gorbachuk I.T., Lutsyk P.P. General course of physics. T.2. - K.: Technique, 2001, Section 10.

Bartashevska Lyudmila
Zaitsev Anatoly

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