DLF
DYDAKTYCZNE LABORATORIUM FIZYCZNE

Instytut Fizyki Doświadczalnej
Wydział Matematyki, Fizyki i Informatyki
UNIWERSYTET GDAŃSKI

Experiment 26

Studying ferromagnetic properties based on hysteresis loops

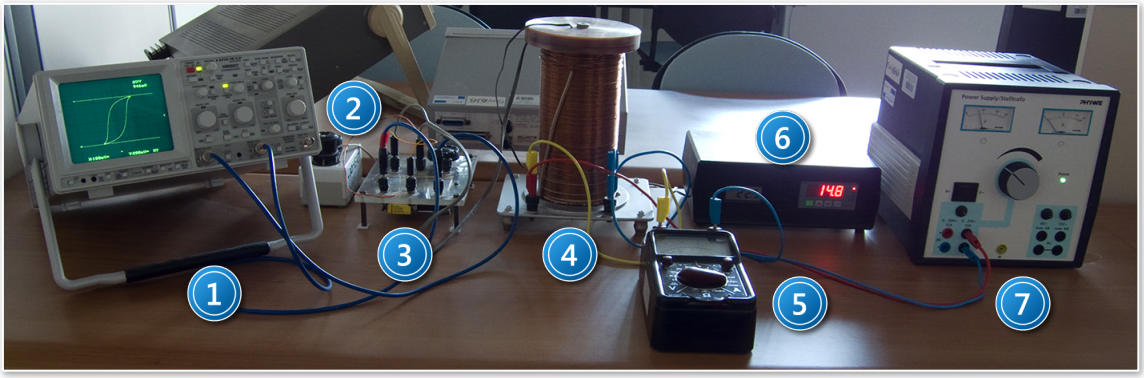
KAPITAŁ LUDZKI
NARODOWA STRATEGIA SPÓJNOŚCI

UNIWERSYTET GDAŃSKI

UNIA EUROPEJSKA
EUROPEJSKI
FUNDUSZ SPOŁECZNY

I. Background theory.

1. Magnetisation, magnetic permeability, magnetic susceptibility.
2. Types of magnetism.
3. Ferromagnetism:
   a) ferromagnetic configurations;
   b) Curie – Weiss law;
   c) energy: exchange, anisotropy, magnetic;
   d) domain structure in solids;
   e) primary magnetization curve of ferromagnetic materials;
   f) hysteresis loop.
4. Other types of magnetic moments.



Picture 1. Experimental setup for studying ferromagnetic properties: 1 – oscilloscope; 2 – power dial; 3 – phase shifter; 4 – ferromagnetic coil; 5 – universal mutimeter; 6 – thermostat; 7 – transformer.

II. Experimental tasks.

1. Familiarise yourself with the setup shown in *Picture 1* and with the component connection diagram in *Figures 2 and 3* and in the *Appendix.*
2. Determine the initial magnetization curve of iron at room temperature.

   To do this, adjust the voltage U across the coils from 6 to 24 V.

   Turn on the transformer (7 in *Picture 1*) and select regulated voltage V~. Adjust the transformer settings as indicated by the multimeter (5 in *Picture 1*).

   Read off the corresponding hysteresis loop parameters from the oscilloscope screen (1 in *Picture 1*) for each coil voltage.
3. Determine the dependence of the area under the hysteresis loop P on the magnetic field strength H for each voltage U as in step 2 above.

4. Determine the dependence of magnetization M of the iron test sample on temperature T.

   Measure the size of the hysteresis loop at constant magnetic field strength for temperatures ranging from room temperature to 150 ^{o}C.

   To do this, set the coil voltage on the meter (5 in *Picture 1*) to about 10 V.

   Measure the height of the hysteresis loop at room temperature.

   Turn on the power controller and thermostat (2 and 6 in *Picture 1*). Set the heating knob on the power controller to position 10.

   After reaching 150 ^{o}C, turn off the controller and start measuring the hysteresis loop (while the sample cools).

5. Present the results of steps 2 – 4 graphically. Make the following plots:

   M = f(H), P = f(H), 1/M = f(T) .

   Interpret the curves obtained.

6. Estimate the Curie – Weiss temperature for the iron sample.

III. Apparatus.

1. Oscilloscope.
2. Power controller.
3. Phase shifter.
4. Set of coils with iron sample.
5. Universal multimeter.
6. Thermostat.
7. Transformer.

IV. Literature.

1. R.P. Feynman, R. Leighton, M.Sands – "*The Feynman Lectures on Physics", Wesley* 2005.
2. Ch. Kittel – "*Introduction to Solid State Physics*", Wiley, 2004.
3. H. A. Enge, M.R. Wehr, J.A. Richards – "*Introduction to Atomic Physics*", Wesley, 1981.

Appendix

Experimental setup wiring diagrams

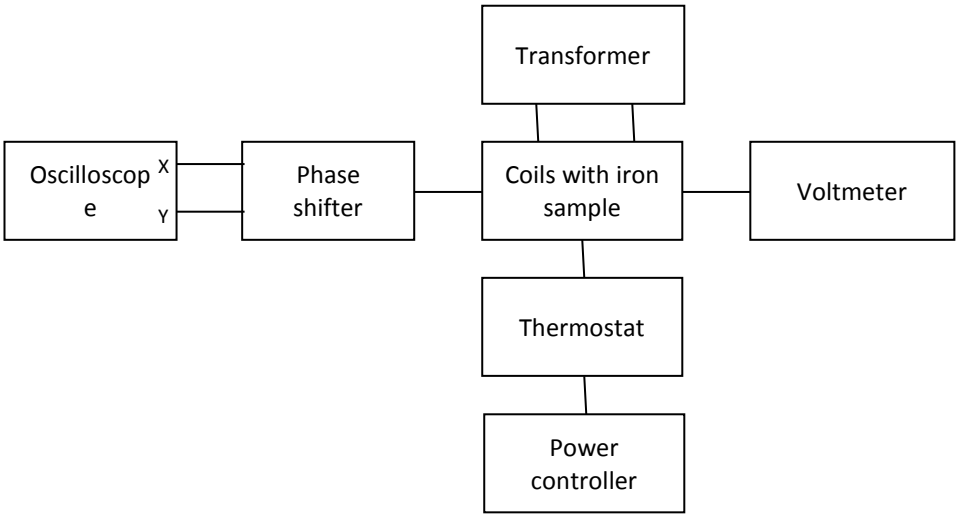


Figure 2. General wiring diagram of the experimental setup.

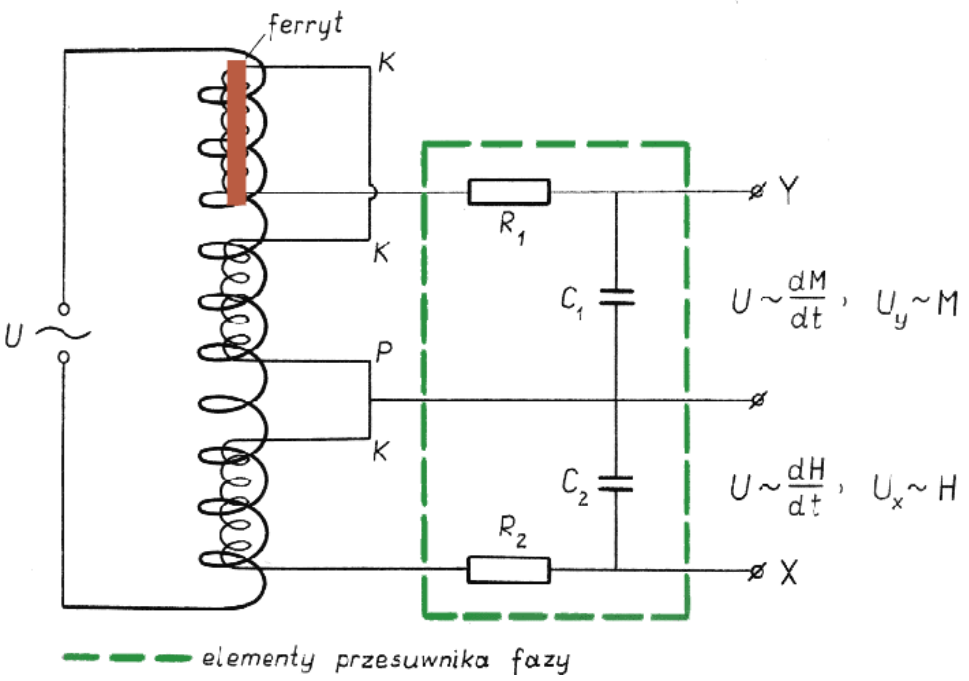


Figure 3. Wiring diagram of the set of coils with phase shifter.