Laboratory work 2.2

Investigation of the electric field

Theory

Electric field is a special type of matter, which consists around electric charges. The field is called electrostatic, if the charges are at rest accordingly to the observer. Each point of the electric field can be characterised by the vector of intensity of electric field E and the potential φ. To investigate the electric field means to define the intensity vector E and the potential φ at each point of the field. For graphical mapping of the electric field the intensity lines and/or equipotential lines are created.

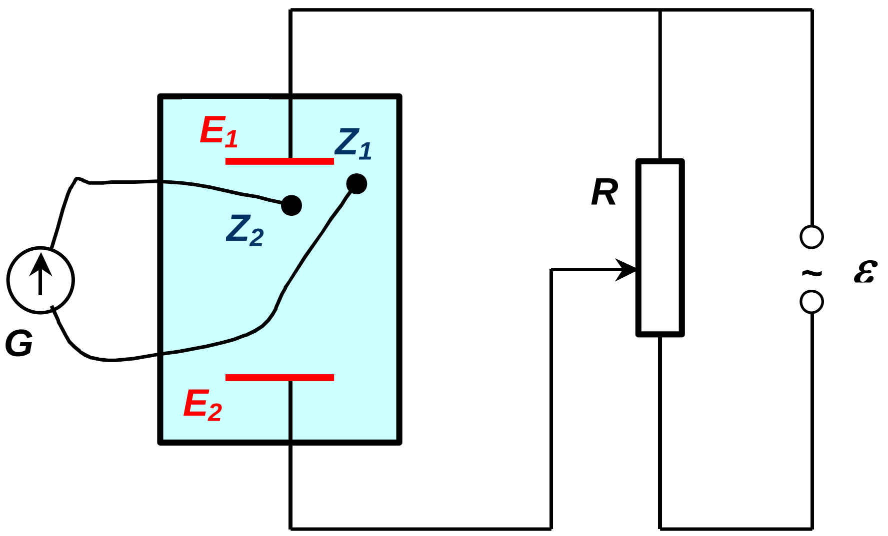
The intensity (or force) lines are created in such a way that the tangent of a line of force at any point gives the direction of E at that point. The equipotential lines are the lines (in two-dimensional case – surfaces), which consists of the points with equal potentials. It is possible to proof, that at each point of the field, lines of intensity are orthogonal (tangents to both are perpendicular) to the equipotential lines. It means, if we know the shape of the equipotential lines, we can also construct intensity lines and vice versa.

The analogy between the potential distribution in electrostatic field and conducting media, where a direct current is flowing can be used for experimental investigation of the electrostatic field. Such conducting media is called *the current field*. Therefore, the investigation of the electrostatic field between charged conductors can be replaced with the investigation of the current field between the same conductors. The potential of these conductors must be kept constant and the resistivity of the conducting media must be sufficiently higher, than the resistivity of charged conductors (electrodes). Such a method, when one field is replaced by other, but analogical, field is called the modelling of the electrostatic field.

To investigate the field, two movable electrodes, called probes are places into the conducting media. Each probe obtains the potential of the point where it is placed. Two probes belong to one equipotential surface if the potential difference is equal to zero. Probes are connected with a measuring device, which resistance must be sufficiently higher, than the resistance of the conducting media to keep the potential distribution unchanged.

In laboratory for the modelling of electric field the tray with electrolyte is used. The bottom of the tray is flat and has gridlines (the reference frame). At the sides of the tray two electrodes are fixed. The electrodes are connected with a source of direct current, which keeps the potential constant. The analogy between fields is true also for alternating potentials; therefore the sources of alternating current are used frequently in this set-up.

The circuit to be established is shown on the Fig.1. The tray must be filled with a thin (*2 – 4 mm*) layer of electrolyte. The tray must be placed horizontally and the thickness of the electrolyte must be constant thorough the tray.



One probe is placed at fixed position (1 - 2 cm to the electrode) and by the other (movable) is necessary to find points (places) with the same potential (potential difference is zero – no current between probes). The number of points with equal potentials must be enough to construct the equipotential line. When the line is constructed, the first probe should be shifted to some centimetres to the next position and the new points for next equipotential line should be defined.

If a metal ring is placed between electrodes, the shape of equipotential lines is changed (field is disturbed). If the nonconducting ring is placed into the tray, the shape of the lines does not change. The field is pictured graphically. At first, the equipotential lines are pictured, than intensity lines are constructed keeping in mind, that equipotential and intensity lines should be perpendicular at crossing points.

The possible appointments:

1. To define the shape of the equipotential lines for two given electrodes.
2. To define the shape of equipotential lines when a) a conductor; b) an isolator is placed in the field.
3. To picture the electric field by constructing equipotential and intensity lines.

Protocol for laboratory work Nr. 2.2..

Students: 1.

2.

Appointments:

1. Define the shape of the *n* equipotential lines for two given electrodes.

2. Define the shape of *m* equipotential lines when a conductor and/or an isolator are placed in the field.

3. Picture the electric field by constructing *n* equipotential and *k* intensity lines.

4. State the existence of electric field inside the rings.

Data of used measuring devices and set-up:

Nr.	***Title***	***Type, number***	***Current type***	***Calibration limit***	***Measuring diapason***	***The value of smallest scale***
1.	Microammeter					

During the measurements is useful not to create the data table, but to show equipotential points graphically.