

## Electromagnetic Fields Laboratory—Organization

### General rules:

The lab programme consists of 8 sessions:

Session 1: Introduction, division into groups, organization of work

Session 2: Review of the theoretical backgrounds to all exercises

Sessions 3-7: Completing exercises

Session 8: Make up of missed exercises and final grading

Students work in groups of 2-3 persons each. The division is decided during the first meeting and can not be changed later. Each group has to complete 5 exercises (one during each lab session). Each session starts with a short quiz of understanding of the pre-lab material, then the exercise is to be completed. The report with description of all measurements and calculations must be submitted at the beginning of the next session.

### Lab exercises:

1. **2D electric field: basic properties**
2. **Calculating mutual capacitances by using the similarities in mathematical description of different fields**
3. **Conducted interferences**
4. **Skin effect**
5. **Introduction to inverse problems in electromagnetics**

Missed labs — There are two types of absences:

1. Absences excused by the teaching assistant and made up in the additional arrangement.
1. Other absences earn a grade of zero.

**Note that teaching assistant will arrange only one make-up lab, at the end of semester.**

### Grading:

Each lab will be graded out of ten points by the teaching assistant. That grade will be based on the report submitted by the group, on quizzes of your understanding of the pre-lab material, and on the teaching assistant's assessment of your actual laboratory procedures. Responsibility for assigning the grade is entirely in the hands of the TA. The grading of the report is common for the group, the other parts are individual.

At the end of the semester your poorest lab grade (which may be an absence that was not made up) will be dropped.

- A single absence that has not been made up will be dropped, and have no further effect on the lab grade.
- If there are two absences that have not been made up, one will be dropped and have no further effect on the lab grade. The other will be assigned a grade of zero. *In addition*, the lab average will be multiplied by 0.80.
- If there are three absences that have not been made up, the lab is failed.

A final lab grade out of 100% will be calculated to determine your class grade using the linear scale.

A student whose final grade on the lab work is reported as below 50% will be have failed the lab.

A student who earns a lab grade of above 50% will have passed the lab.

**Plan of exercises:****E1 2D electric field: basic properties**

Parameters (location, field values, etc.) for all measurements are chosen by the teaching assistant.

1. Approximate location of the 2 selected equipotential lines
2. Estimation of the field intensity in 3-4 selected points: make measurements to estimate value
3. Estimation of the rotation of field intensity in 2 selected points
4. Estimation of the divergence of field intensity in 2 selected points
5. Estimation of the selected line integral of field intensity
6. Estimation of the flux of field intensity through a selected contour
7. Estimation of the total resistance of the model (measurement of the total current)

**E2 Calculating mutual capacitances by using the similarities in mathematical description of different fields**

1. Creation of electric potential contour plots for 2 configurations of the power supply:
  1. 10V on each of electrodes, 0V on the shield
  2. 10V on selected electrode, 0V on the others and on the shield
2. Estimation of  $C_s/C_m$  ratio based on global measurements

**E3 Conducted interferences**

1. Observations of couplings in short, open cables
2. Measurement of electric and magnetic coupling between two parallel cables
3. Measurement of coupling to twisted pair cable
4. Measurement of coupling in ribbon cable

**E4 Skin effect**

For each case measure magnitude of voltage at terminals for two different frequencies (50 and 150Hz) and for two different current densities (total 12 series of measurements). Additionally for selected cases the phase of voltages should be measured.

1. Skin effect in isolated, rectangular cable: influence of current intensity and frequency
2. Skin effect in cable in ferromagnetic slot
3. Skin effect in cylindrical cable

**E5 Introduction to inverse problems in electromagnetics**

1. Estimation of the sensitivity analysis for the simple cost function
2. 1D optimal location by hand Newton method
3. 2D optimal location with FAT field simulator