**FYS S300** Measuring technique
Lecturer: K. Arutyunov
**Exam 10.01.2014**

**Problem 1** (4 points)
**1.1** (1 point) What are the principal (base) units in International System of units (SI)?
**1.2** (1 point) Derive dimensionality of the dielectric and magnetic constants of vacuum: $\varepsilon_0$ and $\mu_0$.
**1.3** (2 points) How the unit of electric current (A) is defined in SI? What are the drawbacks of this definition?

**Problem 2** (6 points)
**2.1** (4 points) Derive the expression of the Hall voltage for a current carrying rectangular sample in perpendicular magnetic field.
**2.2.** (1 point) What materials are usually used as Hall sensors? Why?
**2.3** (1 point) What other methods of measuring magnetic field do you know? Explain principle of operation.

**Problem 3** (5 points)
**3.1** (2 points) Explain principle of operation of an electrometer. Draw schematic diagram, input and output signals. What are the typical experimental situations when electrometer should be used?
**3.2** (3 points) Explain principle of operation of a lock-in amplifier. Draw schematic diagram, input and output signals. What are the typical experimental situations when lock-in amplifier should be used?

**Problem 4** (6 points)
AC voltage $V_{in} = V_o \sin(\omega t)$ is provided to the input of the circuit (Fig. 4) .
**4.1** (1 point) Draw the dependence of the normalized output voltage $|V_{out} / V_{in}|$ on the frequency of the input signal $\omega$.
**4.2** (2 points) At what frequency $\omega^*$ there is an extremum of the function $(|V_{out} / V_{in}|)(\omega)$? Is it MIN or MAX?
**4.3** (3 points) At what frequency $|V_{out}| = |V_{in}| / \sqrt{2}$ ?

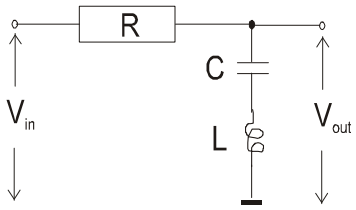

Fig. 4

**Problem 5 (**4 points**).**
**5.1** (2 points) Explain problems appearing in precision electric measurements of high-impedance sources: $R_S$>10 GΩ. Propose solutions to these problems.
**5.2** (2 points) Explain problems appearing in precision electric measurements of low-impedance sources: $R_S$<1MΩ. Propose solutions to these problems.