FYS S300 Mittaustekniikka
Lectures: K. Arutyunov
Exam 14.12.2012

1 (5 points)
Harmonic signal $X = X_0 \sin(\omega t)$ of frequency ω is applied to the X coordinate input of an oscilloscope. Draw the pattern on the screen of the oscilloscope, when another signal is applied to the input of the Y coordinate:
   1.1 (1 point) $Y = Y_0 \sin(\omega t)$;
   1.2 (2 points) $Y = Y_0 \sin(\omega t + \pi)$;
   1.3 (2 points) $Y = Y_0 \sin(2\omega t)$.

2 (6 points)
   2.1 (1 point) Draw dependence of the resistance on temperature for a metal resistor. What temperature scale can be measured with this type of sensor? What biasing mode (voltage or current) is preferable to be used at low temperatures? Why?
   2.2 (1 point) Draw dependence of the resistance on temperature for a semiconductor. What temperature scale can be measured with this type of sensor? What biasing mode (voltage or current) is preferable to be used at low temperatures? Why?
   2.3 (2 points) What other temperature sensors do you know? Explain principle of operation and indicate temperature range of application.
   2.4 (1 point) What are the problems of measuring temperatures at T > 5000 K? What methods can you suggest to measure high temperatures?
   2.5 (1 point) What are the problems of measuring temperatures at T <1 K? What methods can you suggest to measure cryogenic temperatures?

3 (5 points)
   3.1 (3 points) Derive the expression of the Hall voltage for a current carrying rectangular sample in perpendicular magnetic field.
   3.2. (1 point) What materials are usually used as Hall sensors: metals or semiconductors? Why?
   3.3 (1 point) What other methods of measuring magnetic field do you know? Explain principle of operation.

4 (3 points)
Explain principle of operation, draw schematics and write corresponding expressions explaining method of measuring resistance using Wheatstone bridge.

5 (6 points)
   5.1 (3 points) Propose schematics, plot of |Vout/Vin|(ω) dependence and write expressions explaining operation of a high-pass RC filter.
   5.2 (2 points) Plot phase $\varphi(\omega)$ diagram of the high-pass RC filter, where φ is the phase angle between the voltage on the resistor and the voltage on the capacitor, and ω is the frequency of the signal.
   5.3 (1 point) What is the slope of the attenuation below the cut frequency of the high-pass RC filter? What methods can you propose to make this slope higher?