

FYS E430 Microsensors  
Exam on 30.08.2013  
Lecturer: K. Arutyunov

**Problem 1 (6 points)**

- 1.1 (2 points) Draw the temperature dependence of concentration of conducting electrons (or holes) on temperature in a semiconductor.
- 1.2 (2 points) Draw the energy diagram  $E(\mathbf{p})$  of a semiconductor with and without donor / acceptor impurities.
- 1.3 (2 points) Why the impurity levels in a semiconductor are not located in arbitrary points of the momentum space  $\mathbf{p}$ ?

**Problem 2 (5 points)**

- 2.1 (3 points) Give an example of a Hall effect magnetic field sensor. Explain physical principles of operation. Draw schematics of the device.
- 2.2 (1 point) What material(s) are used for this type of sensors? Why?
- 2.3 (1 point) What other types of magnetic field sensors do you know? Explain physical principles of operation.

**Problem 3 (5 points)**

- 3.1 (3 points) Explain principle of charge storage at a metal-insulator-interface?
- 3.2 (2 points) Explain and draw schematics how this method can be used in semiconductor sensors for high-energy particle detection.

**Problem 4 (4 points)**

Explain principle of operation and plot the schematics of the compressed powder (Taguchi) sensor.

**Problem 5 (5 points)**

- 5.1 (2 point) What types of acoustic waves can be excited in solids?
- 5.2 (2 points) Explain how mass of a deposited material can be measured with a piezoelectric microsensor.
- 5.3 (1 point) What other physical properties can be measured using piezoelectric microsensor?