

FYS E430 "Microsensors"

Exam on 21.05.2010

Lecturer: K. Arutyunov

Problem 1 (5 points)

- 1.1 (1 point) Draw the temperature dependence of concentration of conducting electrons (or holes) on temperature in a semiconductor.
- 1.2 (2 points) Draw the energy diagram $\mathcal{E}(\mathbf{p})$ 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 (4 points)

- 2.1 (2 points) Draw schematically a microsensor which can be used as a device to measure acceleration. Explain physical principles of operation, input and output signals.
- 2.2 (2 points) How the device should be modified to turn it into a seismograph (to measure magnitude of low-frequency vibrations)?

Problem 3 (5 points)

- 3.1 (3 points) Give an example of Hall effect magnetic field sensor. Explain physical principles of operation. Draw schematics of the device.
- 3.2 (1 point) What material(s) are used for this type of sensors? Why?
- 3.3 (1 point) What other types of magnetic field sensors do you know? Explain physical principles of operation.

Problem 4 (6 points)

- 4.1 (2 points) Explain physical principles of operation of a photoresistor. Give an example how a photoresistor can be used for sensing electromagnetic radiation.
- 4.2 (3 points) Explain principle of operation of a bolometer. Draw schematic picture of a bolometer. What physical quantities can be measured with this device?
- 4.3 (1 point) What is the principal difference between a photoresistor and a bolometer?

Problem 5 (5 points)

Explain principle of operation, plot the dependence of the output signal on temperature, indicate the temperature range of operation:

- 5.1 (1 point) differential thermocouple;
- 5.2 (1 point) metal resistor;
- 5.3 (1 point) semiconductor resistor;
- 5.4 (2 points) Coulomb blockade thermometer.