

FYS E430  
Arutyunov K.  
Exam 18.03.2011

**Problem 1 (5 points)**

Explain mechanism of absorption of electromagnetic radiation with energy  $E = h\nu$  in an intrinsic semiconductor with energy gap  $E_g$ . Draw corresponding energy level diagrams in case:

- 1.1 (1 point)  $h\nu < E_g$  what is the temperature dependence of the process;
- 1.2 (1 point)  $h\nu \geq E_g$  what is the temperature dependence of the process;
- 1.3 (1 point)  $h\nu \gg E_g$  what is the temperature dependence of the process;
- 1.4 (2 points) How doping of originally pure (intrinsic) semiconductor will affect the above processes?

**Problem 2 (4 points)**

Propose experiments which can determine:

- 2.1 (2 points) type of conductivity in a semiconductor (electron or hole);
- 2.2 (2 points) effective masses of the charge carriers.

**Problem 3 (5 points)**

- 3.1 (2 point) Explain what is Coulomb blockade effect?
- 3.2 (2 points) Draw schematic of a Coulomb blockade thermometer. Explain what parameters should be measured, and how one can deduce the temperature from the measurements.
- 3.3 (1 point) What other types of low temperature thermometers do you know and what is the principle of their operation?

**Problem 4 (6 points)**

Explain principle of operation of the following charged particle detectors:

- 4.1 (2 points) silicon strip detector;
- 4.2 (2 points) silicon drift chamber;
- 4.3 (2 points) charge coupled device.

**Problem 5 (5 points)**

- 5.1 (1 point) What physical parameters can be measured by using piezoelectric properties of materials?
- 5.2 (2 points) Draw schematic construction of the device(s). Explain what are the input and output signals, and how they are related to the measured parameter(s).
- 5.3 (2 points) How the resonant frequency of a piezoelectric device depends on the effective mass of the sensor?