

FYS E430 Microsensors
General Exam on 11.10.2013
Lecturer: K. Arutyunov

Problem 1 (6 points)

- 1.1 (2 points) Draw the temperature dependence of concentration of conducting electrons (or holes) in a semiconductor and a metal.
- 1.2 (2 points) Draw a schematic energy spectrum $E(\mathbf{p})$ of: (a) an intrinsic (pure) semiconductor and (b) semiconductor with 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 (2 points) What is spontaneous and stimulated optical emission?
- 2.2 (3 points) Explain principle of operation and construction of a semiconductor laser?

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 radiation or high-energy particle detection.

Problem 4 (4 points)

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

Problem 5 (5 points)

- 5.1 (2 points) What types of temperature microsensors do you know? Explain physical principles of operation, indicate the temperature range of operation.
- 5.2 (3 points) What are the problems in thermometry at cryogenic temperatures? Give an example of a temperature microsensor capable of measuring temperatures below 10 K.