

Problem 1 (6 points)

- 1.1 (1 point) What is the fundamental difference between metals and semiconductors? Semiconductors and insulators?
- 1.2 (2 points) What for doping of a semiconductor is used? Plot energy diagram of a semiconductor with donor and acceptor impurity levels.
- 1.3 (3 points) What mechanisms of photon absorption in semiconductors do you know? Draw schematics of the processes and explain the main differences.

Problem 2 (4 points)

- 2.1 (1 point) What is the principal of operation of an optical waveguide?
- 2.2 (1 point) What are the spontaneous and stimulated optical emissions?
- 2.3 (2 points) Explain principle of operation and construction of a semiconductor laser?

Problem 3 (3 points)

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

Problem 4 (5 points)

Explain principle of operation, draw schematics of the device, input and output signals of the following magnetic field microsensors:

- 4.1 (2 points) Hall probe.
- 4.2 (2 points) Magnetodiode.
- 4.3 (1 point) What other magnetic field sensors do you know? Explain principle(s) of operation.

Problem 5 (7 points)

- 5.1 (3 points) Explain what is Josephson effect? Write the main expressions describing the physical properties of a Josephson junction.
- 5.2 (3 points) Draw schematic of a SQUID. Explain what are the input and output signals, and how they are related to the measured parameters.
- 5.3 (2 points) What other physical parameters can be measured using a SQUID?