

TUT	Automation Science and Engineering	10.5.2012
MIT-4016	Sensor physics, exam. 15.5.2012	J. Halttunen

No literature ! You have to select five and only five of the six questions!

All kinds of calculators allowed!

1. Explain shortly a) sensor b) Poisson's ratio c) piezoelectric effect d) thermoelectric effect e) Hall effect.
2. The principle of classification of transducers into self-generators, modifiers and modulators. Give an example of each type.
3. Discuss the properties of optical fibres which may be used for sensing purposes, and the advantages and disadvantages of such systems.
4. Capacitive displacement transducers.
5. a) Calculate the thickness of the matching layer for the transducer shown in Figure 1. The layer is made of aluminium (velocity of sound $6,32 \cdot 10^3$ m/s) and the transducer is working at a frequency of 2 MHz.
 b) What should be the optimum characteristic impedance R_2 of the matching layer between PZT-ceramics (characteristic impedance $R_1 = 19,7$ MPa·s/m) and mineral oil (density 825 kg/m³, velocity of sound $1,44 \cdot 10^3$ m/s)?

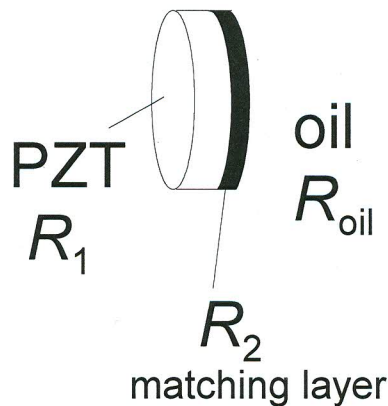


Figure 1.

6. A vortex flowmeter is used to measure water flow. The piping consists of a long round pipe with inside diameter of 50 mm. The kinematic viscosity of water in measurement conditions is $1 \cdot 10^{-6}$ m²/s.
 - a) Calculate the minimum reliably measured average flow velocity in the cross-section, if the minimum pipe Reynolds number is 10000.
 - b) What is the vortex shedding frequency, if the average flow velocity in the 50 mm pipe is 3 m/s. Suppose that the Strouhal number of the rectangular bluff body is 0,26 and the width of the bluff body is 0,3 times the inside diameter of the pipe.