

ELEC-E5710 Sensors and Measurement Methods 01.10.2018

Exam, five (5) exercises.

NB! If you have received credit for one (1) or two (2) exam questions by solving the homework exercises, choose and answer to only four (4) or three (3) questions out of five. The additional answers will not be taken into account (the last ones on the sheet of answers).

1. Explain *briefly* the following concepts
 - a. Bourdon tube
 - b. Uncertainty
 - c. Sensitivity
 - d. LVDT (linear variable differential transformer)
 - e. Piezoresistive effect
 - f. Photomultiplier tube
2. Explain the traceability of measurands. What is the SI system of units? How are National metrology institutes related to the traceability chain? What is the difference between working and primary standards?
3. Which phenomenon is the optical temperature measurement based on? Define the term emissivity and describe how should it be taken into account when measuring the temperature of an object optically?
4. The velocity of air is measured using a pitot tube based on a mercury manometer (Figure 1). What is the velocity, if $h_m = 6$ cm? Densities of mercury and air are $13,6 \text{ g/cm}^3$ and $1,2 \text{ kg/m}^3$, respectively.

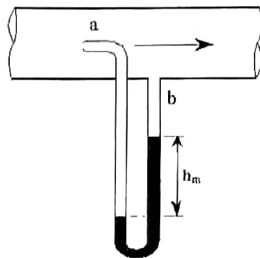


Figure 1.
Pitot tube
based on a
mercury
manometer

5. A cylinder shaped NTC thermistor ($R_0 = 10 \text{ k}\Omega$ at $25 \text{ }^\circ\text{C}$, $\beta_0 = 3988 \text{ K}$ at $25 \text{ }^\circ\text{C}$, $\gamma = +2.679 \text{ K/K}$, diameter $d_S = 2.9 \text{ mm}$ and length $l_S = 4 \text{ mm}$) is set in a cylinder shaped hole in anodized aluminium (diameter $d_H = 3.4 \text{ mm}$, depth $l_H > l_S$). Calculate the resistance of the thermistor at $50 \text{ }^\circ\text{C}$. Determine the self-heating at the same temperature when the measuring current is 1 mA and the hole is filled with silicon paste with the thermal conductivity $k_{Si} = 149 \text{ W m}^{-1} \text{ K}^{-1}$ or air with the thermal conductivity $k_{air} = 0.026 \text{ W m}^{-1} \text{ K}^{-1}$.