ELEC-E5710 Sensors and Measurement Methods 11.4.2017

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. Liquid column manometer
   b. Uncertainty
   c. Sensitivity
   d. Emissivity
   e. Piezoelectric effect
   f. Seebeck effect

2. Explain:
   a. The difference between radiometry and photometry (also in terms of measurement equipment).
   b. The operating principle of differential reluctance pressure sensor. How can you measure reluctance?

3. Introduce typical error sources for (resistance) temperature measurements and explain how to minimize/compensate them (contact measurement).

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 g/cm^3 and 1,2 kg/m^3, respectively.

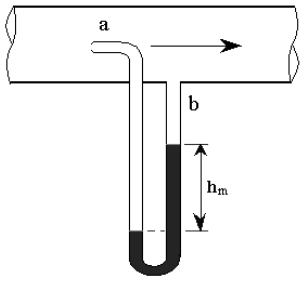

Figure 1. *Pitot tube based on a mercury manometer*

5. *Differential capacitive sensor*. Show that the differential capacitive sensor in Figure 2 ($C = C_2 - C_1$) has a more linear response than a single capacitive sensor.

   Determine the sensitivity ($\partial V_{out}/\partial \Delta\delta$) of the reactive bridge circuit in Figure 3, which is used to measure the sensor in Figure 1. $R_2 = R_1$.

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Hint: apply the series expansion

$$\frac{1}{\delta \pm \Delta\delta} \cong \frac{1}{\delta}\left[1 \mp \frac{\Delta\delta}{\delta} + \left(\frac{\Delta\delta}{\delta}\right)^2 \mp \left(\frac{\Delta\delta}{\delta}\right)^3 + \ldots\right] \quad \text{and} \quad \frac{\Delta\delta}{\delta} << 1.$$

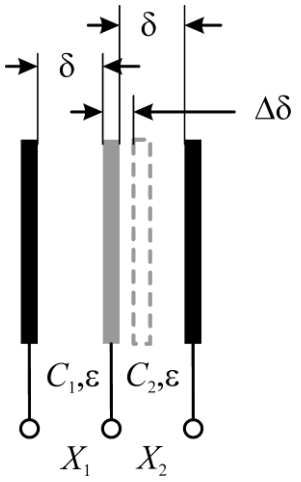

Figure 2. *Differential capacitive sensor*

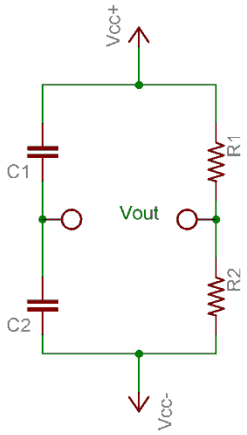

Figure 3. *Bridge circuit.* $R_1 = R_2$.