ELEC-E5710 Sensors and Measurement Methods 27.5.2019

Exam, five (5) exercises.

NB! If you have received credit for one (1) or two (2) exam questions by solving the homework exercises, you may choose and answer to only four (4) or three (3) questions out of five. If you have additional answers, the weakest answers will be compensated.

1. Explain *briefly* the following concepts and their *differences*.
   a. *Sensor* versus *Transducer*
   b. *Type A* uncertainty versus *Type B* uncertainty
   c. *Sensitivity* versus *Linearity*
   d. *Thermocouple* versus *Thermopile*
   e. *White (thermal) noise* versus *1/f-noise*
   f. *Operational amplifier* versus *Instrumentation amplifier*

2. Explain the traceability of measurands. What is the SI system of units and what are its base units? What major changes were made to the SI system of units on 20.5.2019?

3. Which phenomenon is the optical temperature measurement based on? Define the term emissivity and describe how it should be taken into account when measuring the temperature of an object optically?

4. You are using a throttling venture tube to measure the flow velocity of water (density $\rho = 1000$ kg/m^3) utilizing pressure difference. The inlet and outlet diameters of the venture tube are $D_1 = 0.1$ m and the throttle diameter is $D_2 = 0.08$ m. The pressure difference at the throttle is measured using a manometer as in Figure 1, and the height difference between the columns is $h = 2.5$ mm. What is the flow velocity at the inlet of the sensor? What is the flow velocity at the outlet?

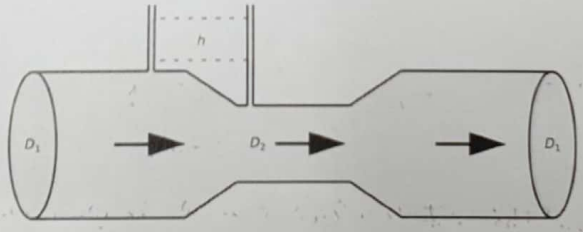

Figure 1. Venture tube.

5. You are measuring deformation of a steel plate with a 100 Ω strain gauge. Depending on bending, the resistance of the strain gauge varies within 100 – 102 Ω
   a) Present / design simple electronics with which you can convert the strain gauge signal ($R = 100 – 102$ Ω) to a voltage signal $U = 0 – 5$ V.
   b) The temperature of the object to be measured varies a lot (-10 – +25 °C). Can this cause problems with the measurement and if so, how can you solve them?
   c) The object to be measured has to be placed 10 m away from your electronics. Will this cause problems with your measurement circuit and how can you solve them?