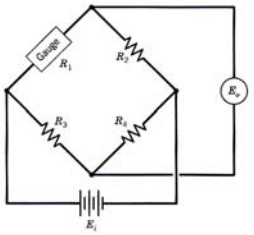
SE104 Homework 5

1. List three major reasons that may lead to failure of strain-gauge measurement.

2. A Wheatstone bridge is shown below. R_1, R_2, R_3, and R_4 are four strain gauges having the same initial resistance of 120 Ω. Their gauge factors are 2, 2, 10, 5, respectively. They are mounted on a rod. The Young's modulus of the rod material is 200 GPa and the Poisson's ratio is 0.3. The rod diameter is 10 cm and its length is 1 m. The rod is subjected to a tensile force. Gauges 1 and 4 are mounted along the axial direction, i.e. the loading direction. Gauges 2 and 3 are mounted along the transverse direction. The applied DC voltage on the bridge E_i = 10 V. The bridge output δE_0 = 40 mV. (a) Is the bridge initially balanced? (b) What is the engineering strain along the loading direction? (c) What is the true strain? (d) What is the tensile force?



Hint: If $R_1 = R_2 = R_3 = R_4$, then

$$\frac{\delta E_o}{E_i} = \frac{1}{4}(\varepsilon_1 \mathrm{GF}_1 - \varepsilon_2 \mathrm{GF}_2 + \varepsilon_4 \mathrm{GF}_4 - \varepsilon_3 \mathrm{GF}_3)$$

It is possible to purchase matched sets of strain gauges for a particular application, so that $\mathrm{GF}_1 = \mathrm{GF}_2 = \mathrm{GF}_3 = \mathrm{GF}_4$, and

$$\frac{\delta E_o}{E_i} = \frac{\mathrm{GF}}{4}(\varepsilon_1 - \varepsilon_2 + \varepsilon_4 - \varepsilon_3)$$

3. We have 4 identical strain gauges of the same initial resistance (R) and the same gauge factor (GF). They will be used as R_1, R_2, R_3, and R_4 in a Wheatstone bridge, respectively. We want to measure the tensile strain of a rod subjected to a tensile force. What is the maximum bridge constant (κ) that we can reach? Clear state your assumptions.

4. Describe at least one method to eliminate the temperature effect in strain-gauge measurement.