Transducer and Instrumentation – Assignment 06

Measuring Forces and Torques

1) A strip material with a rectangular cross section 20mm x 5mm is subjected to an axial load of 400N. Two strain gauges attached along the axis and transverse direction measure strains $1231\mu strain$ and -432 $\mu strain$. Estimate the modulus of elasticity and of Poisson's ratio for the material.

2) A strain gauge with a nominal resistance of 150Ω has a gauge factor 2.5. If a single strain gauge is used as one of the resistances in a Wheatstone bridge with 150Ω in each arm, what is the strain ϵ experienced by the strain gauge if $v_{out} = 10mV$ for a reference voltage $v_{in} = 3.3V$. If two such strain gauges are used such that the strain experienced by one strain gauge is ϵ and the other is $-\epsilon$, what is the strain if the corresponding $v_{out} = 10mV$. What will be strain if there are four such strains gauges with two experiencing strains of ϵ and the other two experiencing strains of $-\epsilon$?

3) Consider a strain gauge with a nominal resistance of 100Ω and gauge factor 2.5. The strain gauge contains two lead wires each with resistance 10Ω. What is the effective gauge factor of the strain gauge with the lead wires? The purpose of this problem is to demonstrate that the low nominal strain gauge resistance implies that the resistance of the lead wires can have a significant effect on the measurement system.

4) Consider a strain gauge-based force measurement system using four strain gauges, the uncertainty associated with the different components of this system are as follows:

   a) Strain gauge resistance: $\pm 0.12\%$
   b) Gauge factor: $\pm 0.05\%$
   c) Bridge resistance: $\pm 0.2\%$
   d) Supply voltage: $\pm 0.5\%$

   What is the expected uncertainty in the measurement of the output voltage of the Wheatstone bridge built using these above components?