CE203/SC301 Tutorial 4: Computerised Data Acquisition

1. A new type of light-weight, stiff material called BigM is being investigated for possible use in a new generation of car bodies. A mock up of a car chassis is built using the new material. A team is formed to study the strain-stress characteristics of BigM. A number of high stress points on the car body are to be monitored. It is proposed that each point be monitored using 2 strain gauges. Instrumentation amp and 12 bit ADC are suggested to ensure high accuracy result. The I.A. proposed is a commercial device based on the standard 3 Op-amp topology.

   (a) Design the instrumentation system in block diagram form. You are to advise on the bridge topology used in the measurement system to achieve maximum output signals from the strain gauges. The strain gauges are mounted on the same side of the chassis. The bridge is to be powered by a +5V supply.
   (b) Express, Vd, the differential voltage across the bridge as a function of the microstrain, hence, determine the range of Vd, for a microstrain range of 0 to 2000 (tension only).
   (c) Find the common mode voltage output (Vcm) of the bridge.
   (d) Redraw the system in terms of Vd and Vcm.
   (e) Given that the ADC resolution is 1 mV/LSB, find the gain required of the I.A. Hence, specify the values of Rf and Rg.
   (f) What is the smallest microstrain detectable by the system? Comment on the practical difficulty.
   (g) Suppose the I.A. used has a CMRR of 100db, what is the magnitude of the common mode voltage at the input to the ADC? What is the effect of this common mode signal on the performance of the ADC system?
   (h) If another I.A. with CMRR of 160db is used, recompute the finding of (g). What is your observation?