Component Level Laboratory

Mechanical Sensor Fundamentals: Strain Gauge and Load Cell

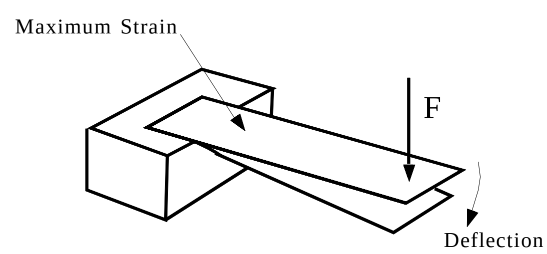
Objective:

The objective of this experiment is to study the strain gauge's characteristic and apply it as a load cell in a weighing scale made from a cantilever beam. LabVIEW will be used to collect data and display the weight and time response of the strain gauge.

1. Introduction

A cantilever beam is a beam supported at one end. Forces applied to the free end, as from the weight of an object, will cause the beam to deflect as shown below. This deflection results in a stretching of the upper surface of the beam and a compression of the lower surface. Strain gauges can be used to measure this stretching (or compression)

In this experiment a cantilever beam has been constructed with strain gauges mounted in the region of maximum stretching. The strain gauges will be used in a bridge circuit. The small voltage will be detected with a high gain differential amplifier and thus provide a voltage proportional to the beam deflection and the load (weight).

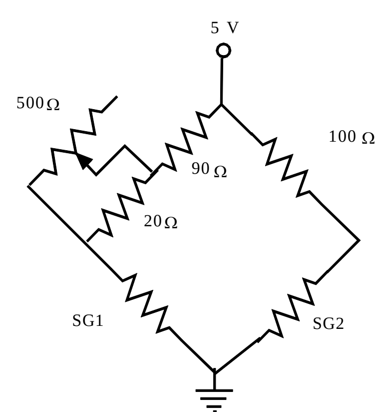


2. Signal Conditioning Circuits Design

A. How to identify whether the strain gauge is active or only used for temperature compensation?

B. Consider the bridge circuit shown on the right. This bridge circuit uses a 500 Ω variable resistor to allow for nulling of the bridge when no weight is in the pan. If the strain gauge's resistance is 120 Ω. What should be the variable resistor's value in order to null the bridge?

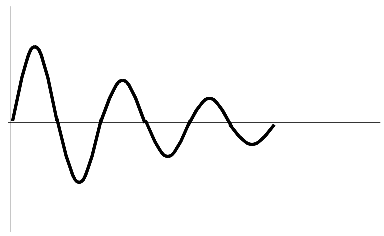
C. Design an input-offset compensated differential amplifier with a gain of about 500 to produce a signal suitable for input to the computer.



D. Electrical noise can be a problem with such small voltages and high gains. Design and construct a low-pass RC filter with a critical frequency of about 0.5 Hz. Simulate the circuit in Multisim and verify the filter's function.

3. Second Order Time Response of Strain Gauge

The strain gauges exhibit 2nd order time response dynamic behavior. Review the 2nd order time response concept in Chapter 1. When a sudden change is applied as the input, the sensor will produce decaying oscillations in the output. The response is characterized by a natural frequency of oscillation, f_N, and a decay constant, α



$$v(t) = V_0 e^{-\alpha t} \sin(2\pi f_N t)$$

The peak value $v(t) = V_0 e^{-\alpha t}$ occurs when $\sin(2\pi f_N t) = 1$. How can we determine the natural frequency of oscillation and the decay constant?

4. Read about Strain Gauge and Strain Gage selection from:

http://www.omega.com/literature/transactions/volume3/strain.html

http://www.nmbstraingages.com/selectinggages.html

Reminder: Bring some nickel, dime and quarter to the lab!