X

Unit 3 - Week 2

Week-2 Assignment on Strain gauge and Load cell

1) *1 point*

The resistance of a strain gauge increases by 0.15 ohm for an applied strain (ε) of 1.5×10^{-4}. The nominal resistance of strain gauge is 250 ohm. Determine its gauge factor (λ).

- a) 4.0
- b) 2.0
- c) 3.5
- d) 0.0

Accepted Answers:
a) 4.0

2) *2 points*

A unity-gain quarter bridge is shown in Fig. 1. The strain gauge is connected in one arm of th bridge whereas the other three arms contain one fixed resistance each. All four resistances c the bridge are 120 ohm each. The bridge produces an output (e_o) of 1 mV for a strain of 50 micrometer/meter when E_{ex} is 4 V. Determine the gauge factor (λ) of the strain gauge.

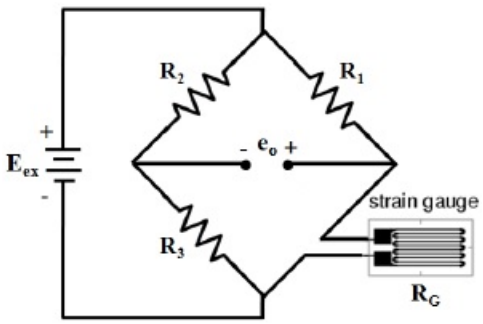

Fig. 1. Unity gain Quarter Bridge

- a) 4.02
- b) 3.5
- c) 2.01
- d) 0.0

Accepted Answers:
c) 2.01

3) *5 points*

130 ohm strain gauge with a gauge factor 2.06 is used as a sensor for measuring the strain of 900 micrometer/meter.

(i) Determine the change in resistance and change in resistance per unit resistance.
(ii) Determine the output voltage e_0 from an initially balanced Wheatstone bridge if the excitation voltage (E_{ex}) is 9V.
(iii) If the strain on the gauge is reduced to a value so that e_0 is 3 mV, determine the new strain.

- (a) (i) 0.24 Ω, 1.854×10^{-3}; (ii) 4.167 mV; (iii) 647.9 micro
- (b) (i) 0.12 Ω, 1.854×10^{-3}; (ii) 2.083 mV; (iii) 647.9 micro
- (c) (i) 0.24 Ω, 1.854×10^{-3}; (ii) 2.083 mV; (iii) 647.9 micro
- (d) (i) 0.24 Ω, 1.854×10^{-3}; (ii) 4.167 mV; (iii) 323.96 micro

Accepted Answers:
(a) (i) 0.24 Ω, 1.854×10^{-3}; (ii) 4.167 mV; (iii) 647.9 micro

4) **2 points**

A strain gauge with 130 ohm resistance and a gauge factor of 2.05 is placed in a Wheatstone's bridge (refer Fig. 1). The value of other three fixed resistances of the bridge is also 130 ohm each. With a bridge supply current (I_{ex}) of 30 mA, the output of the bridge corresponds to 40 units for 900 micro strains. (i) What would be the output (in units) if the current is increased to 45 mA under identical conditions? (ii) With the bridge supply current of 30 mA, what will be the output if the gauge factor of the strain gauge is 3.5 under 900 micro strain?

- (a) (i) 45 units, (ii) 68.29 units
- (b) (i) 30 units, (ii) 34.14 units
- (c) (i) 40 units, (ii) 34.14 units
- (d) (i) 60 units, (ii) 68.29 units

Accepted Answers:
(d) (i) 60 units, (ii) 68.29 units

5) **5 points**

As shown in Fig. 2, four strain gauges (SGs) are attached to the four vertical surfaces of a column type of load cell of 24 cm height and 12 cm^2 area. Gauge on opposite faces experience either transverse or axial forces. The gauges are connected to a bridge circuit (see Fig. 3) in such a way that any temperature effect is compensated. The bridge output (e_o) is amplified by an ideal differential amplifier. Calculate the amplifier gain (A_d) when its output (e_A) is 1.5V for a compressive force of 2.5×10^5 N. Use the following data:- gauge resistance =120 ohm, λ = 2.05, Bridge excitation voltage = 5 VDC , Young's modulus of elasticity (Y) = 2.1×10^{11} N/sq.m, Poisson's ratio (ν) = 0.285.

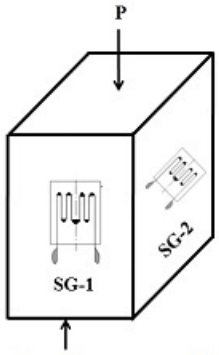

Figure 2. Column type load cell. SG-3 is present on the opposite surface of SG-1, while SG-4 is opposite to SG-2.

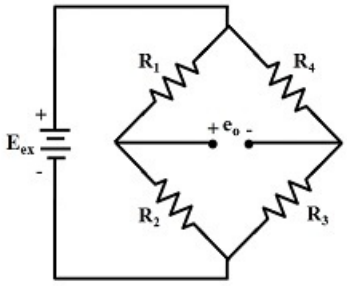

Figure 3. Wheatstone's bridge

- (a) 115.63
- (b) 231.26
- (c) 400
- (d) 200

Accepted Answers:
(b) 231.26

6) ***1 point***

A strain gauge has a nominal resistance of 120 ohm and a gauge factor of 2.05. The gauge is in a Wheatstone's bridge with other three resistances of 120 ohm each. The bridge is excited by 6 V DC. If the strain gauge is subjected to a strain of 120 mircometer/meter. What will be the magnitude of the output at the detector of the bridge?

- (a) 0.368 mV
- (a) 0.736 mV
- (c) 1.472 mV
- (d) 2.944mV

Accepted Answers:
(a) 0.368 mV

7) ***2 points***

Two identical strain gauges of resistances 120 ohm and gauge factor +2.0 each, are attached to a column type load cell of Poisson's ratio (v) = 0.3 as shown in Fig. 5. Find the unbalanced output voltage per unit micro strain applied to the load cell (refer Fig. 6). A vertical compressive load is applied to the load cell. (R_3=R_4= 500 ohm and E_{ex} = 2 V DC)

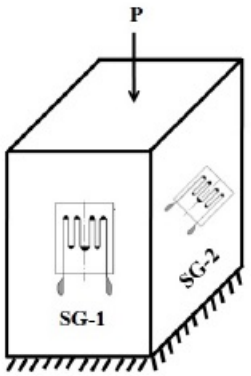

Fig. 5. Column type load cell.

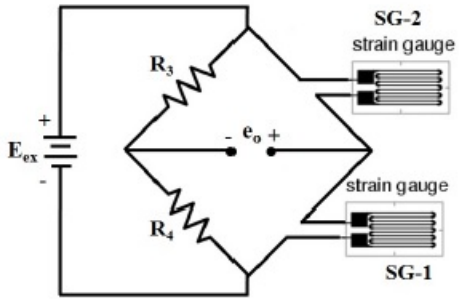

Fig. 6. Wheatstone's bridge

- (a) -0.65 micro V/strain
- (b) +0.65 micro V/strain
- (c) -1.30 micro V/strain
- (d) +1.30 micro V/strain

Accepted Answers:
(c) -1.30 micro V/strain

8) ***2 points***

As shown in Fig. 7, a cantilever type load cell comprising of two strain gauges is experiences strain of 500 micrometer/meter due to force F. The resistance of the strain gauges is 12 ohm each and their gauge factor is 2.05 each. Determine the unbalanced bridge output (refe Fig. 8). (R_3=R_4=120 ohm and E_{ex} = 2 V DC)

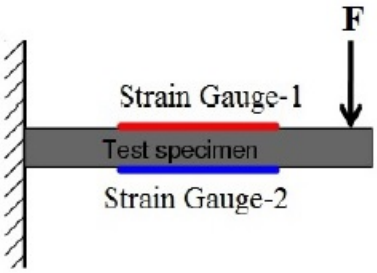

Fig. 7. Cantilever type load cell.

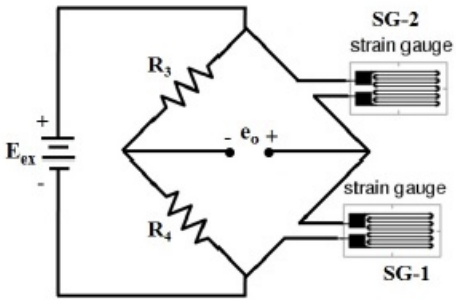

Fig. 8. Wheatstone's bridge

- (a) 0 mV
- (b) 3.075 mV
- (c) 2.05 mV
- (d) 1.025 mV

Accepted Answers:
(d) 1.025 mV

Previous Page End