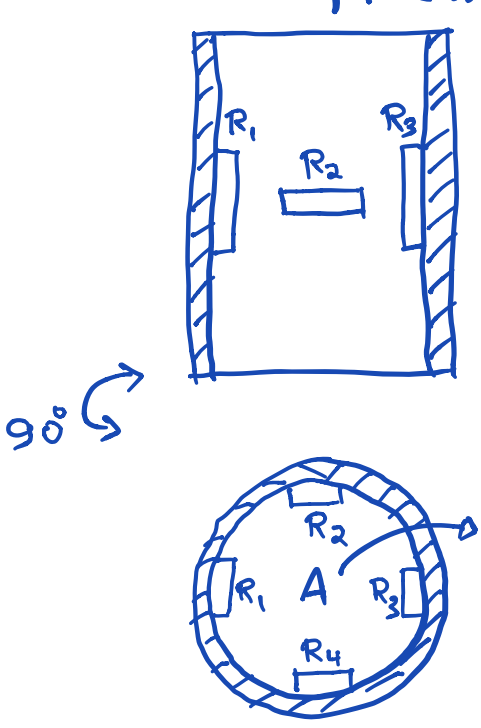
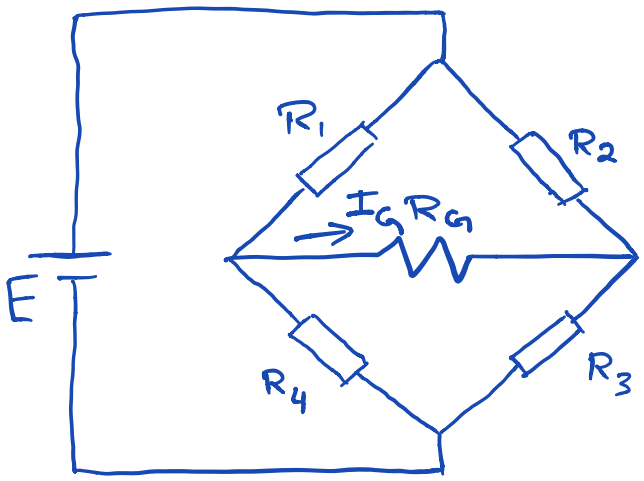
12.03.2019

ELL 301

Nakra & Chaudhry

Pg 122, Problem 4.4





Ammeter resistance $R_G = 500\,\Omega$

- Force $= 10^5$ N
- Young's modulus $= 2.07 \times 10^{11}$ N/m^2
- Cross-sectional Area $= 2$ cm^2

Strain?

$$\text{Young's modulus} = \frac{\text{Stress}}{\text{Strain}} \quad \text{Stress} \rightarrow \frac{F}{A}$$

$$\Rightarrow \text{Strain} = \frac{\text{Stress}}{\text{Young's modulus}}$$

$$= \frac{10^5 \text{ N} / 2 \text{ cm}^2}{2.07 \times 10^{11} \text{ N/m}^2}$$

$$= \frac{10^5 \text{ N} / 2 \times 10^{-4} \text{ m}^2}{2.07 \times 10^{11} \text{ N/m}^2}$$

$\rightarrow$ 0.0024

$\rightarrow$ 2.415×10^{-3}

$R_1 = R_2 = R_3 = R_4 = 1000\,\Omega$ initially,

Initially bridge is balanced

Therefore, $I_G = 0$

$R_1 \rightarrow R_1 + \Delta R_1$, $R_2 \rightarrow R_2 + \Delta R_2$, and so on,

$\Rightarrow$ Current that starts to flow,

$I_G = ?$

This is a function of E, R_1, R_2, R_3, R_4

$\Delta R_1, \Delta R_2, \Delta R_3, \Delta R_4$

How to relate the strain to change in resistance?

Gauge Factor $= \dfrac{\Delta R/R}{\Delta L/L}$ $\rightarrow$ relative change in resistance / strain

$\rightarrow$ 2.1

Strain gauge arrangements are made for two purposes,

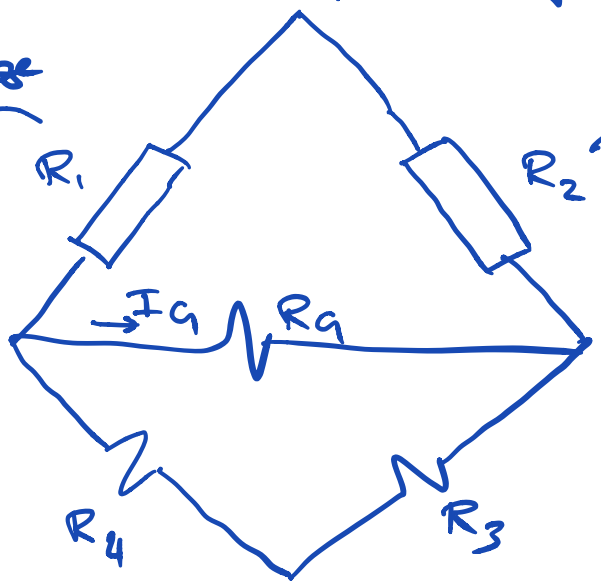
1. higher sensitivity, for example, placing identical strain gauges on opposite arms of the bridge.

2. temperature compensation

temperature changes may cause change in resistance, mimicing the effect of strain

→ undesirable.

How do we compensate for this?

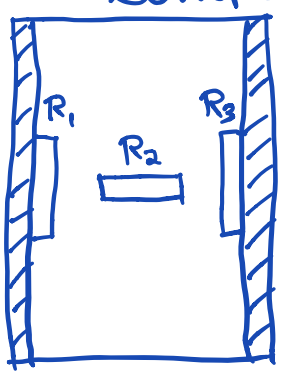


strain gauge used to measure the strain

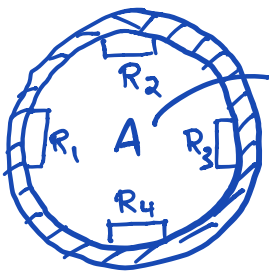
also a strain gauge, but a "dummy" strain gauge, which doesn't measure strain, but is placed so that it has same temperature environment as R_1.

Simultaneous change in R_1, R_2 due to temperature has a compensatory effect.

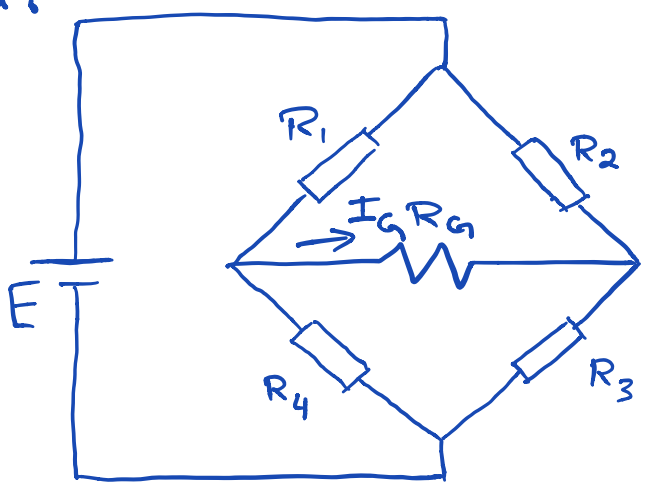
— Does this arrangement have any temperature compensation effect?



90°

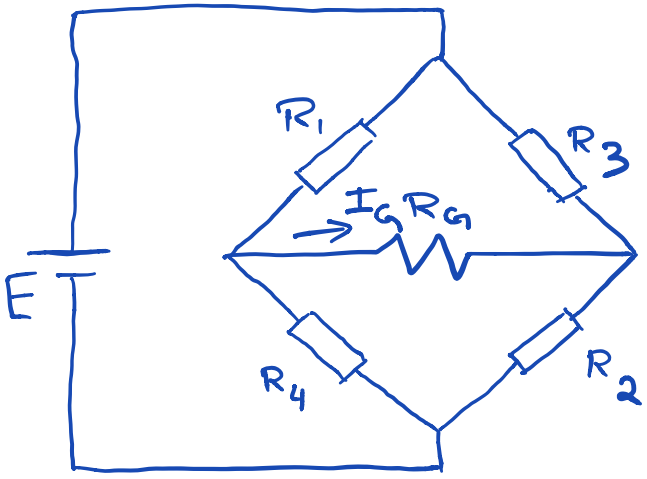


area of cross-section



Ammeter resistance $R_G = 500\Omega$

Yes. if temperature heats/cools the cylinder, the changes in resistance of adjacent arms cancel out each others effects.



What happens in this case?

- will it measure strain?
- will it be temperature compensated?