Assignment 6

Question 1

Given:

- Cross section of the rectangle 20 mm x 5 mm
- Two strain gauges attached along the axis and transverse direction 1231μ strain and -431μ strain

Axial strain $\varepsilon_a = 1231\mu$ strain, Transversal strain $\varepsilon_t = -431\mu$ strain

Poison ratio is given by:

$$\nu = -\frac{\varepsilon_t}{\varepsilon_a}$$

$$\nu = -(\frac{-431\mu}{1231\mu})$$

$$\nu = -(\frac{-431}{1231})$$

Poison's ratio is:

$$\nu = 0.35$$

Stress applied on the strain gauge is given by:

$$\sigma = \frac{F}{A}$$

$$\sigma = \frac{400}{20mm \times 5mm}$$

Young's modulus is given by:

$$E = \frac{\sigma}{\varepsilon}$$

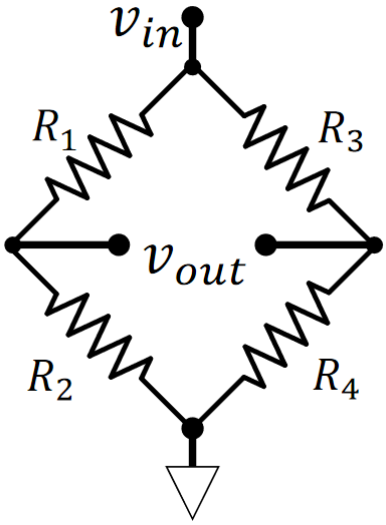
$$E = \frac{400}{20 * 5 * 10^{-6} * 1231 * 10^{-6}}$$

$$E = 3.25GPa$$

Question 2

Given the following for a strain gauge:

- Nominal resistance: $R = 150\Omega$
- Gauge factor: $G = 2.5$
- $V_{in} = 3.3V$
- $V_{out} = 10mV$



Whereas $R_1 = R_2 = R_3 = R_4 = R$

$$\frac{V_{out}}{V_{in}} = \frac{\Delta R}{4R + \Delta R} \, or \, \frac{\Delta R}{4R}$$

$$\frac{10mV}{3.3V} = \frac{\Delta R}{4R}$$

$$\frac{10 * 10^{-3}}{3.3} = \frac{\Delta R}{4 * 150}$$

$$\Delta R = 1.81\Omega$$

We know that $\frac{\Delta R}{R} = G\varepsilon$

$$\varepsilon = \frac{\Delta R}{GR}$$

Bringing to a common equation that can be used for other two cases:

$$\varepsilon = \frac{\Delta R}{2.5 * 150}$$

$$\varepsilon = \frac{\Delta R}{375}$$

We know that $\Delta R = 1.81\Omega$

$$\varepsilon = \frac{1.81}{375}$$

$$\varepsilon = 0.0048$$

Case 2:

if two strain gauges are attached, such that the strain experienced by one strain gauge is ε and the other is$-\varepsilon$

$$\frac{V_{out}}{V_{in}} = \frac{\Delta R}{2R}$$

$$\frac{10 * 10^{-3}}{3.3} = \frac{\Delta R}{2 * 150}$$

$$\Delta R = 0.91\Omega$$

Therefore the strain is given by:

$$\varepsilon = \frac{0.91}{375}$$

$$\varepsilon = 0.0024$$

Case 3: if four strain gauges are attached, such that the strain experienced by two strain gauge is ε and the other two is$-\varepsilon$

$$\frac{V_{out}}{V_{in}} = \frac{\Delta R}{R}$$

$$\frac{10 * 10^{-3}}{3.3} = \frac{\Delta R}{150}$$

$$\Delta R = 0.45\Omega$$

Therefore the strain is given by:

$$\varepsilon = \frac{0.45}{375}$$

$$\varepsilon = 0.0012$$