Department of Mechanical, Materials and Manufacturing Engineering

The University of Nottingham

Electromechanical Devices MMME2051

Exercise Sheet 10 – Analog Electronics, Op Amps, Strain Gauge

10.1 Draw and explain how an accelerometer works.

10.2 Accelerometers are always used with an op-amp circuit – why is this?

10.3 Draw an amplifier circuit that could be used with a Wheatstone bridge. Write down the equation relating the potential developed across the Wheatstone bridge to the output of the amplifier circuit.

10.4 A Wheatstone bridge develops a potential of 0.01V, an amplifier circuit attached to the bridge has $R_1=R_2=10$kOhm and $R_f=R_g=100$kOhm. What will the output voltage of the amplifier circuit be?

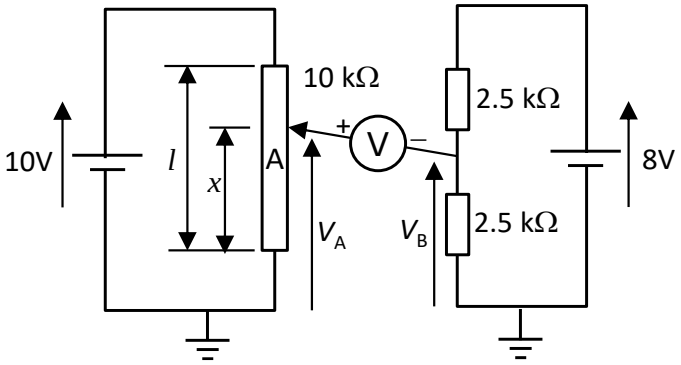
10.5 Calculate the resistance of an aluminum wire 50m long, 1mm diameter at 0°C and 50°C, given that $\rho=2.7 \times 10^{-8}$ Ωm at 0°C and $\alpha=0.0038$ K^{-1}.

1.72Ω, 2.11Ω

10.6 The 10kΩ potentiometer in Fig 7.2 has an active length l . A voltmeter with infinite internal resistance is connected between node *B* and the potentiometer wiper (node *A*).

Calculate the voltmeter reading when the potentiometer wiper is set at a distance x measured from the earthed end of:

(i) 0.8 l
(ii) 0.5 l
(iii) 0.4 l
(iv) 0.2 l



+4V, +1V, 0V, -2V.

10.7 A strain bridge comprises two 120Ω resistors, one active gauge and one unstrained gauge for temperature compensation. The two gauges have unstrained resistances of 120Ω and a strain gauge factor of 2.2. The bridge supply voltage is 5V. Calculate the strain when the voltmeter reading is 2mV.

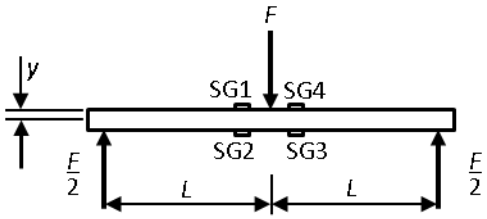
ε = *727 microstrain*

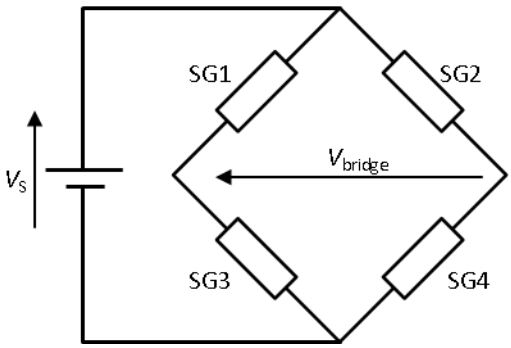
10.8 A force, *F* of 10N is exerted at the centre of the steel beam shown in Fig 7.4a. Four identical strain gauges each with an unstrained resistance of 350 Ω and a strain gauge factor, *G* of 2.4 are glued to the upper and lower surfaces of the beam, which is 400 mm long and 3 mm deep. The second moment of area of the beam, *I* is 3.6 x 10^{-11} m^4 and Young's modulus for steel, *E* is 207 x 10^9 Pa.

The four strain gauges are connected to a strain gauge bridge as shown in figure below:

- V_s is 10V.
- Bending moment at centre of beam, $M = \frac{FL}{2}$, where L=half the beam length.
- Stress adjacent to load $\sigma = \frac{My}{I}$ where y=half the depth of the beam.
- Strain,$\varepsilon = \frac{\sigma}{E}$

Calculate the bridge output voltage, V_{bridge}





4.83 mV