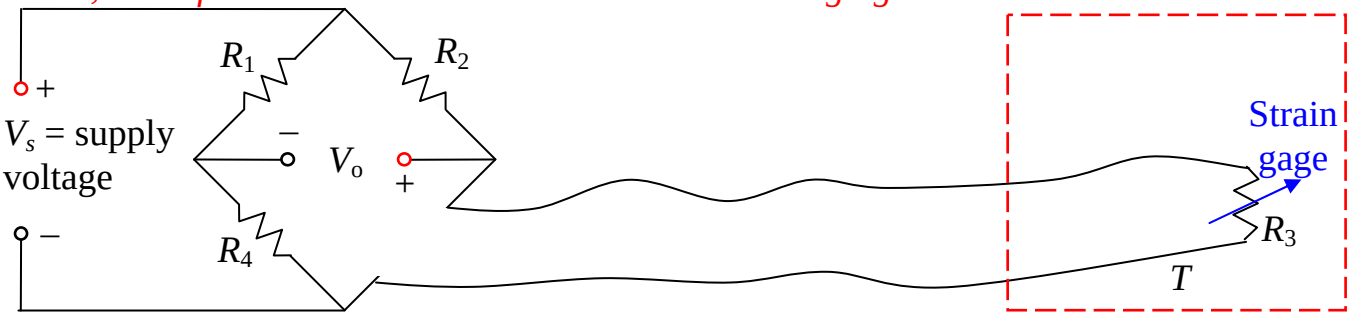
Today, we will:

- Discuss additional items about strain gages that are not in the pdf notes: **temperature compensation, transverse strain, strain on arbitrary surfaces**
- Discuss the learning module **strain gage rosettes**
- Do some review example problems – stress, strain, and strain gages

Example: Strain gages and temperature compensation

Given: A quarter-bridge strain gage circuit is constructed using R_3 as the strain gage, as sketched. The beam being measured is located a short distance from the bridge circuit. Unfortunately, the temperature at the location of the experiment fluctuates a lot, and the resistance of the strain gage is also quite sensitive to temperature. **We get a *false reading* when the temperature changes –** *a change in temperature appears (falsely) like a change in strain, even if the actual strain on the beam is not changing.*

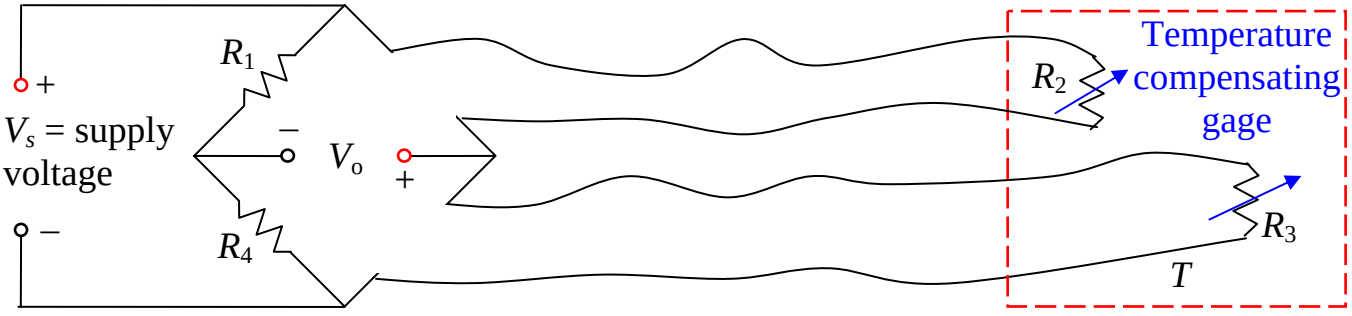


To do: Figure out a way to eliminate the temperature effect.

Solution:

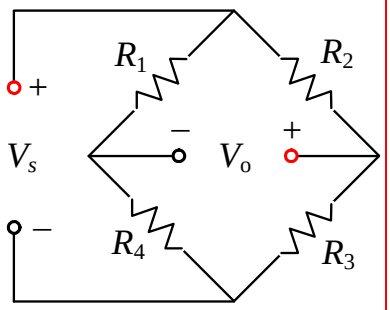
Recall the approximate equation for V_o when all four resistors of the Wheatstone bridge have small changes in resistance:

$$\frac{V_o}{V_s} \approx \frac{R_{2,\text{initial}} R_{3,\text{initial}}}{\left(R_{2,\text{initial}} + R_{3,\text{initial}}\right)^2} \left(\frac{\delta R_1}{R_{1,\text{initial}}} - \frac{\delta R_2}{R_{2,\text{initial}}} + \frac{\delta R_3}{R_{3,\text{initial}}} - \frac{\delta R_4}{R_{4,\text{initial}}} \right)$$



Example: Strain gages

Given: A Wheatstone bridge circuit is constructed to measure strain in a component of a truss beam on a bridge.



- All resistors and strain gages are nominally 120 ohms.
- The strain gage factor is 2.05.
- The supply voltage to the bridge is 6.00 V.
- With no load, the bridge is balanced ($V_o = 0$).
- An axial strain of 350 μstrain is applied such that the strain gage is in tension.

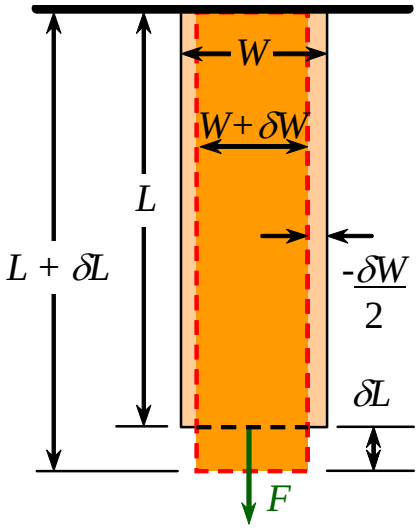
(*a*) To do: Calculate the output voltage in mV when resistor 2 is the strain gage.

(*b*) To do: Calculate the output voltage in mV when resistors 1 and 2 are the strain gages, and *both* strain gages are in tension with $\varepsilon_a = 350$ μstrain.

(*c*) To do: Calculate the output voltage in mV when resistors 1 and 3 are the strain gages, and *both* strain gages are in tension with $\varepsilon_a = 350$ μstrain..

Solution:

Tranverse Strain: Consider a hanging beam, of dimensions L and W, with thickness t.



Example: Strain gages and transverse strain

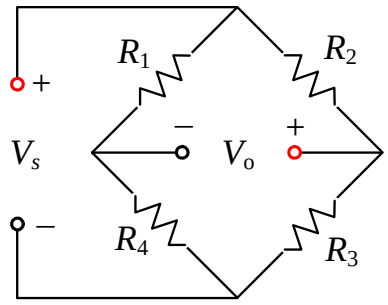
Given: A 2.8 cm × 5.0 cm rectangular rod is stretched from its initial length of 0.4000 m to a length of 0.4005 m.

- The modulus of elasticity of the rod material is 95.0 GPa (gigapascals).
- Poisson's ratio of the rod material is 0.333.

(*a*) To do: Calculate the axial stress in units of MPa.

(*b*) To do: Calculate the transverse strain in units of microstrain.

(*c*) To do: A strain gage with a strain gage factor of 2.10 is glued to the rod before it is stretched, aligned with the direction of stretching. A quarter bridge Wheatstone bridge circuit is constructed, with the strain gage as resistor R_1. The strain gage is balanced before the rod is stretched. The bridge supply voltage is 7.50 V. Calculate the output voltage (in mV) of the bridge after the rod is stretched.



Solution: