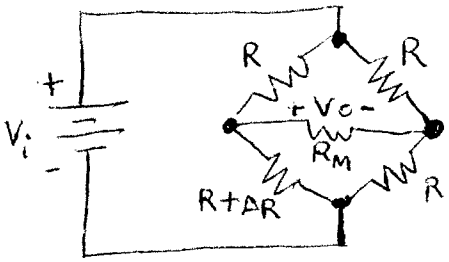
ECE554 Instrumentation
Homework Assignment #5

1. Text problem 2.1 (See hints on reverse side!)

2. Derive the Vo vs. ΔR relationship for the loaded "1-active arm" bridge circuit that was discussed in class. Use the Thevenin Equivalent method of analysis, which was applied to the loaded 4-active arm bridge circuit that was presented in the class notes.

   SHOW THAT



$$Vo = Vi \cdot \frac{\frac{\Delta R}{R}}{4 + \frac{2 \cdot \Delta R}{R} + \frac{1}{R_M} \cdot (4 \cdot R + 3\Delta R)}$$

3. (a) Find the change in resistance of a nichrome wire at room temperature (gage factor 2.5) as it is stretched from a length of 3.00 meters to a length of 3.01 meters. Assume that this wire has a circular cross section of 0.001 cm^2, and that the resistivity of nichrome at room temperature is 100 μΩ*cm. (Answer: 0.25 Ω).

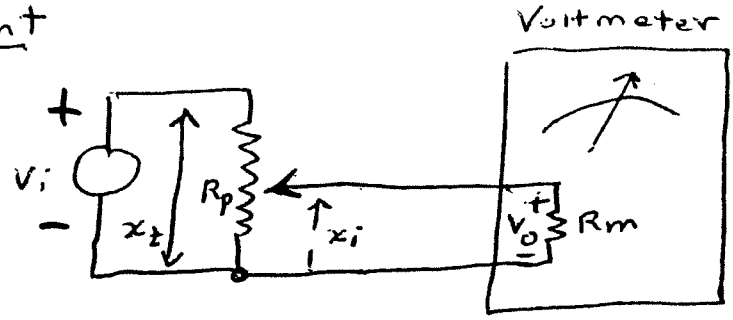
(b) Find the change in resistance of this nichrome wire if its temperature rises 20 degrees C above room temperature. Ignore any temperature-induced dimensional changes. (From above table, note that the temperature coefficient of nichrome resistivity is given as tempco = $10*10^{-5}$/degree_C, thus the resistivity of nichrome that is 20 degrees C above room temperature is the original resistivity multipled by (1 + tempco*20). (Answer: 0.06 Ω)

4. Text Problem 2.3

5. Text Problem 2.7

6. Text Problem 2.8 (Answer C = 80 pF, thus the plate spacing is xo = 11.1 μm.

P 2.1 Hint



$$\text{Error} = \left(\frac{x_i}{x_t} - \frac{V_o}{V_i}\right)$$

Assume $R_p < R_m \Rightarrow \frac{R_p^2}{R_m^2}$ negligible compared to $\frac{R_p}{R_m}$.

Let $\boxed{F \triangleq x_i/x_t}$

First, Show:

$$\frac{V_o}{V_i} = \frac{1}{\frac{1}{F} + \frac{R_p}{R_m}(1-F)}$$

Let $\boxed{\epsilon \triangleq R_p/R_m} \Rightarrow \text{Error} = F - \frac{V_o}{V_i} = F - \frac{1}{\frac{1}{F} + \epsilon(1-F)}$

Next, show $\frac{d(\text{Error})}{dF} = 1 - (1+\epsilon F - \epsilon F^2)^{-1} - F(-1)(1+\epsilon F - \epsilon F^2)^{-2}(\epsilon - 2\epsilon F)$

Set this deriv = 0 and

Ignore $\epsilon^2, \epsilon^3, \ldots$ terms compared to ϵ

Show: $\Rightarrow \boxed{F = 0, 2/3}$

$\Rightarrow \therefore \text{Error} = 0.67 - \frac{1}{1.5 + 0.33\epsilon}$