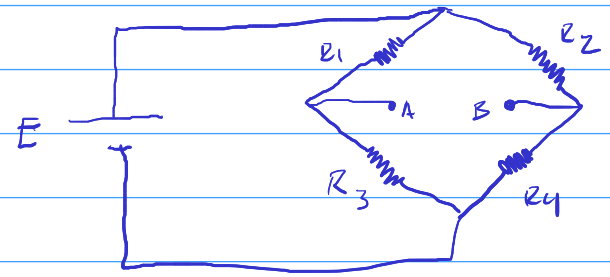
Chapter 7

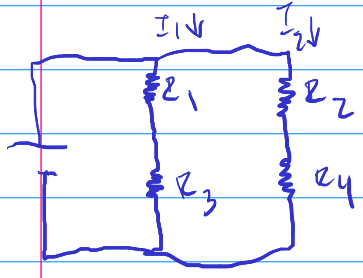
Wheat Stone Bridge

are widely used in measurement devices

1. Balanced Bridge
2. Unbalanced Bridge

1.) Balanced Bridge:





$$V_A = \frac{R_3}{R_1 + R_3} E \qquad V_A = I_1 \cdot R_3$$

$$V_{R_3} = V_A = I_1 R_3 = V_3$$

$$V_{R_1} = V_1 = I_1 R_1$$

$$V_{R_2} = V_2 = I_2 R_2$$

$$V_{R_4} = V_4 = I_4 R_4$$

A Bridge is Balanced if VAB = 0

$$\frac{V_1}{V_3} = \frac{V_2}{V_4}$$

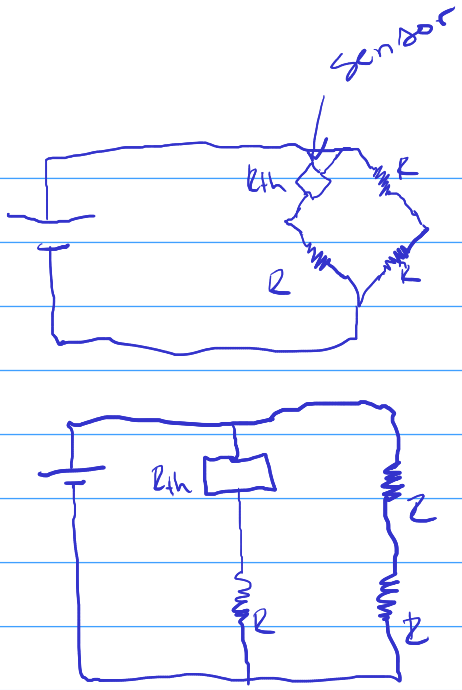
VAB = VA-VB = 0

$$\frac{I_1 R_1}{I_3 R_3} = \frac{I_2 R_2}{I_4 R_4}$$

$$\frac{R_1}{R_3} = \frac{R_2}{R_4}$$

$$R_1 = R_3 \frac{R_2}{R_4}$$

2.) Unbalanced Bridge



$$V_A = \frac{R}{R_{th}+R}E$$

$$V_B = \frac{R}{R+R}E = \frac{1}{2}E$$

$$V_A - V_B = \frac{R}{R_{th}+R}E - \frac{1}{2}E$$

$$= \left(\frac{R}{R_{th}+R} - \frac{1}{2}\right)E$$

$$= V_{AB}$$

$$\Delta R_{th} = R - R_{th}$$

$$R_{th} = R - \Delta R_{th}$$

$$V_A - V_B = \left[\frac{R}{R-\Delta R_{th}+R} - \frac{1}{2}\right]E$$

$$= \left[\frac{R}{2R-\Delta R_{th}} - \frac{1}{2}\right]E$$

$$= \frac{2R-(2R-\Delta R_{th})}{2(2R-\Delta R_{th})}E$$

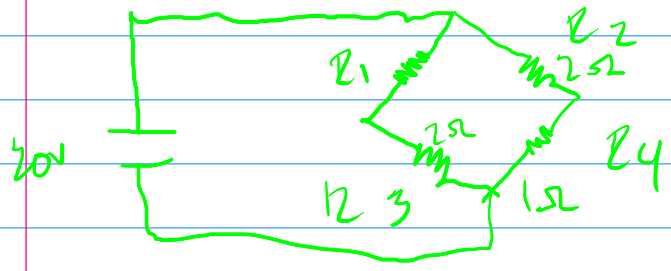
$$= \frac{2R-2R+\Delta R_{th}}{2(2R-\Delta R_{th})}E$$

$$V_{AB} = \frac{\Delta R_{th}}{2(2R - \Delta R_{th})} E = \frac{\Delta R_{th}}{4R} E$$

is $\Delta R_{th} << 2R$

$$V_{AB} = \frac{\Delta R_{th}}{4R} E$$

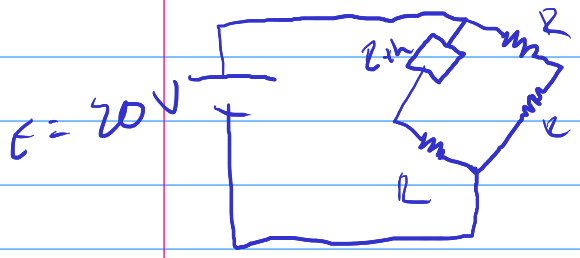
Example: if the bridge is balanced, find R1



$$\frac{R_1}{R_3} = \frac{R_2}{R_4}$$

$$\frac{R_1}{2} = \frac{2}{1} \qquad R_1 = 4\Omega$$

Example: for a bridge at room temperature, Rth = 25k
If the temperature changes to 35C, Rth = 15k, find Vab



$R = 25K$

$R_{th} = 25K$

$V_{AB} = 0$

$R_{th} = 15K$

$V_{AB} = ?$

$$V_A = \frac{R}{R + R_{th}} E$$

$$= \frac{25K}{25K + 15K}(20V) = 12.5V$$

$$V_B = \frac{R}{R + R} E = \frac{1}{2} E = 10V$$

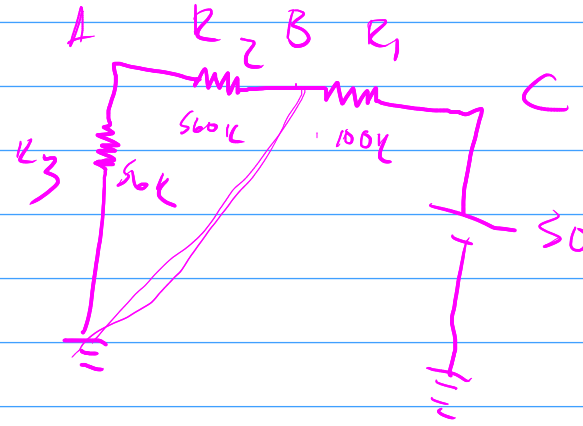
$V_A - V_B = 2.5V$

$$V_A - V_B = \frac{\Delta R_{th}}{4R} E = \frac{10K}{4(25K)} 20V$$

$35 - 25 = 10$

$$\frac{V}{temp} = \frac{2.5V}{10} = 0.25V/1^\circ$$

HomeWork



$$V_{R_2+R_3} = V_B$$

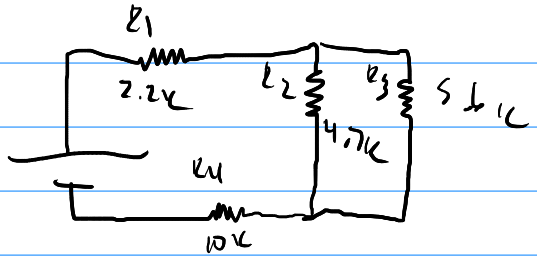
$$\frac{R_2 + R_3}{R_1 + R_2 + R_3}\,(50V)$$

$$V_A = V_{R_3}$$

$$= \frac{R_3}{R_1 + R_2 + R_3}\,(50V)$$

Lab 10

$$R_{23} = \frac{R_2 R_3}{R_2 + R_3} = \frac{(4.7k)(5.6k)}{4.7k + 5.6k} = 2.56k$$



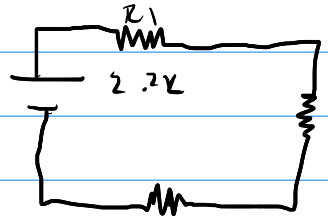
$$R_T = 2.2k + 2.56k + 10k$$

$$= 14.76k$$

$$V_{R1} = \frac{R1}{R_T}(12V)$$

$$= \frac{2.2k}{14.76k}(12V)$$

$$= 1.79V$$



$V_{R2} = V_{R3} = V_{R23}$ =

$$\frac{2.5\text{k}}{14.76\text{k}}(12\text{V})$$

$= 2.08\text{V}$

$$V_{R4} = \frac{10\text{k}}{14.76\text{k}}(10\text{V})$$

$= 6.13\text{V}$