Chapter 5: Direct Current Bridges

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Electrical Instrumentation

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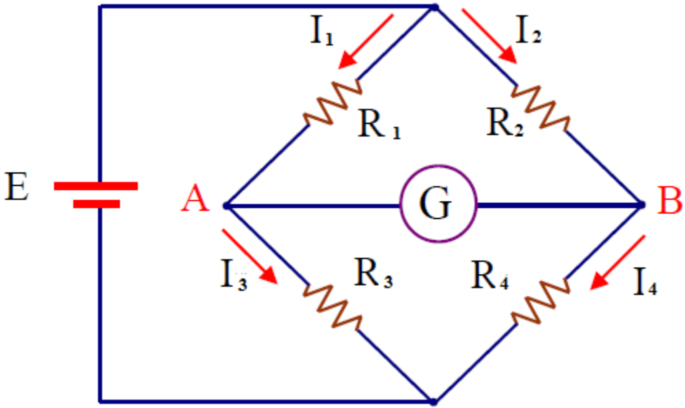
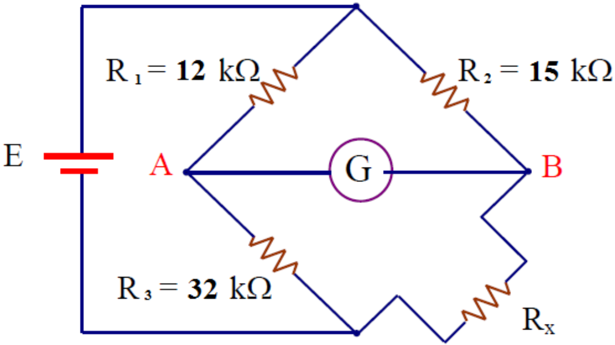

I1
I2
R1
R2
E
A
G
B
I3
R3
R4
I4

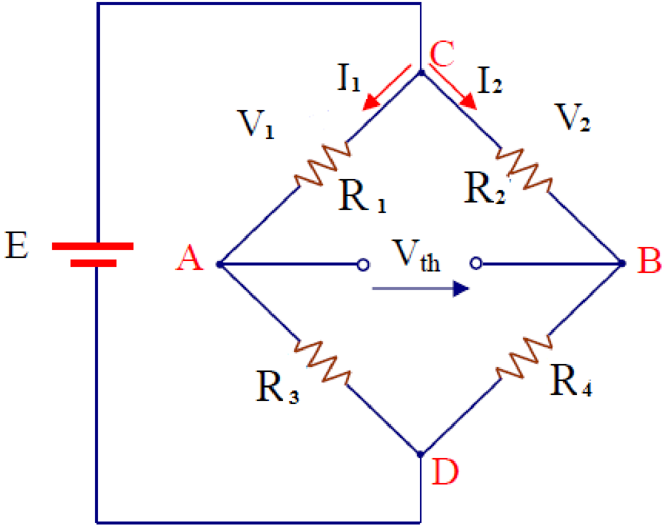
Example 1

Determine the value of the unknown resistor, R_x in the circuit of the Figure assuming a null exists (current through the galvanometer is zero).



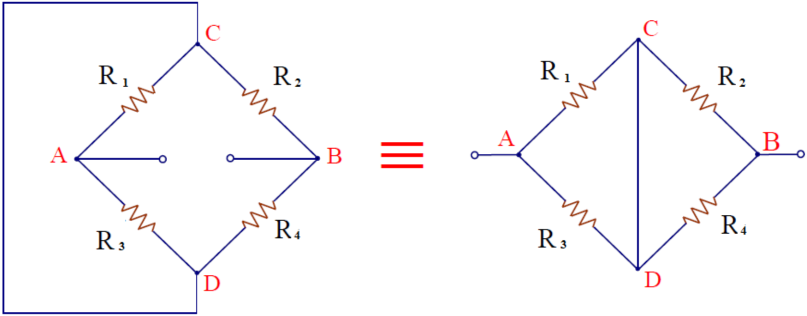
2. General solution of Wheatstone Bridge

First: find V_{Th}



General solution of Wheatstone Bridge

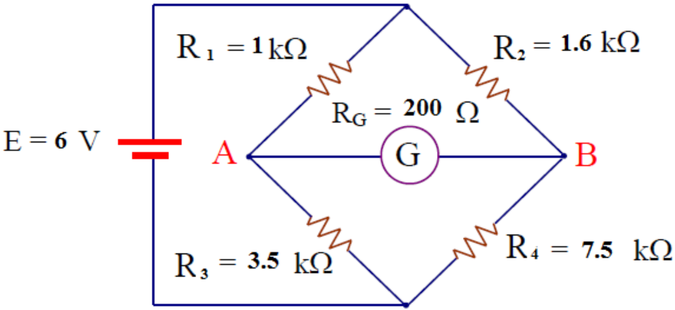
Second: find R_{Th}



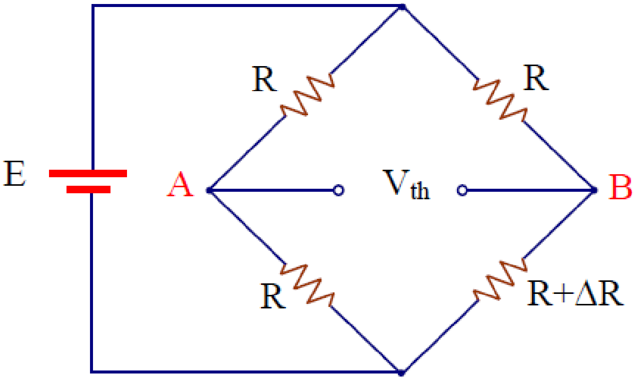
$$I_G = \frac{V_{Th}}{R_{Th} + R_G} \tag{1}$$

Example 2

Calculate the current through the galvanometer in the circuit.

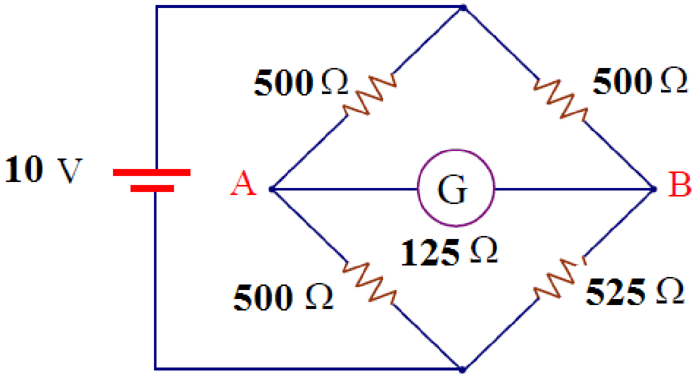


3. Slightly Unbalanced Wheatstone Bridge



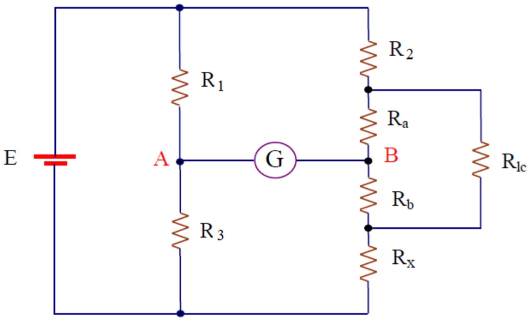
Example 3

Use the approximation given in the last section to calculate the current through the galvanometer in the circuit. The galvanometer resistance $R_g = 125\ \Omega$



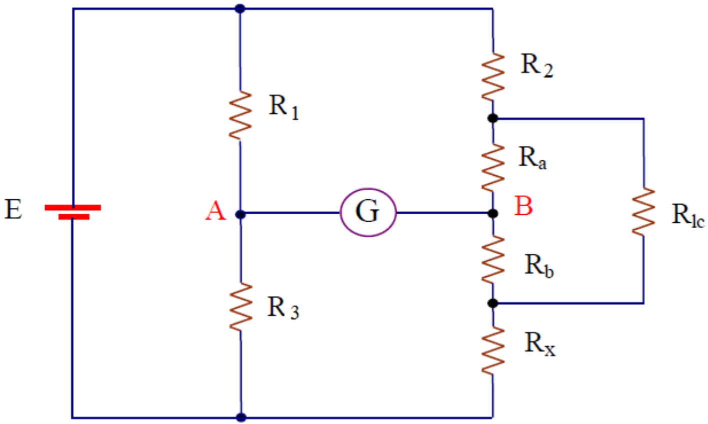
4. Kelvin Bridge

- The kelvin bridge is a modified version of the Wheatstone bridge.
- The purpose of the modification is to eliminate the effects of contact and lead resistance when measuring unknown low resistor.
- Resistors in the range 1 Ω to approximately 1 $\mu\Omega$



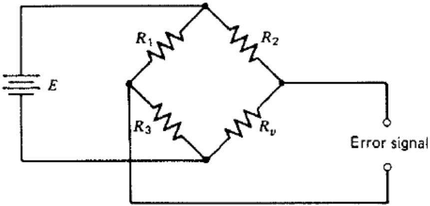
Example 4

If, in the Figure, the ratio of R_a to R_b is 1000, R_1 is 5 Ω, and $R_2 = 2R_1$. Find the value of R_x



5. Bridge-Controlled Circuits

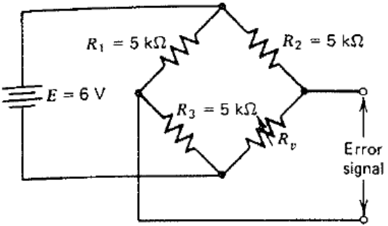
- When a bridge is used as an error detector in a control circuit, the potential difference at the output of the bridge is called an **error signal**.
- Passive circuit elements such as strain gauges, temperature-sensitive resistor (thermistors), or light-sensitive resistors (photoresistors) produce no output voltage.
- However, when they are used as one arm of a Wheatstone bridge, a change in their sensitive parameter (heat, light, pressure) produces a change in their resistance.
- This causes the bridge to be unbalanced. thereby producing an **output voltage or an error signal**.



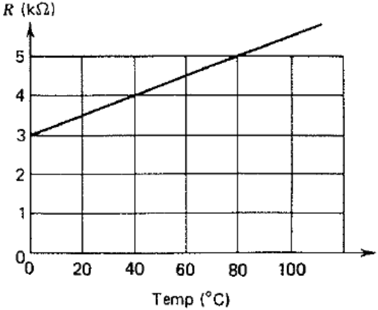
Example 5

Resistor R_v in Figure (a) is temperature-sensitive, with the relation between its resistance and temperature as shown in Figure (b).

1. At what temperature the bridge is balanced.
2. The amplitude of the error signal at 60 $^\circ$.

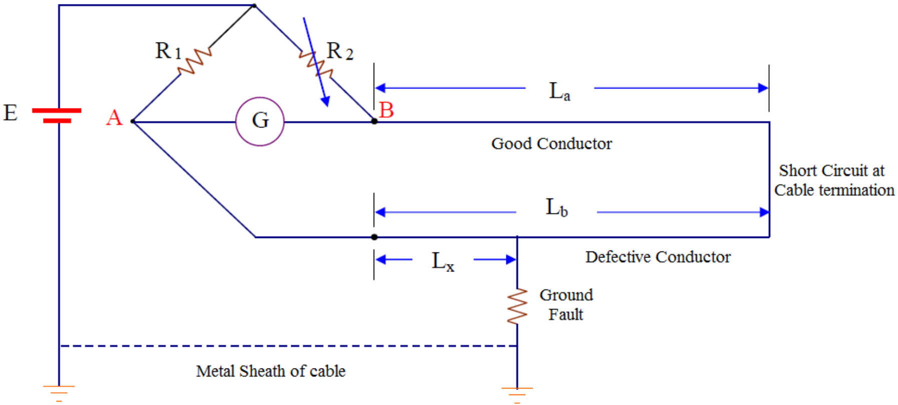


(a) Circuit



(b) Variation of R_v with temperature

6. Applications on DC Bridges - Murray Loop



Example 6

The Murry loop test of Figure consists of two conductors of the same material and the same cross-sectional area. Both cables are connected 5280 m from the test setup at the cable terminal. The bridge is balanced, when R_1 is 100 Ω and R_2 is 300 Ω. Find the distance from the ground fault to the test set.