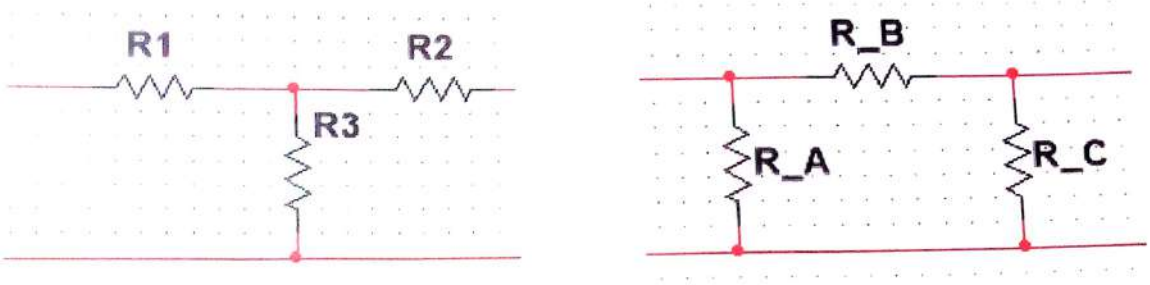
Laboratory III

EPOKA UNIVERSITY

T and PI circuits

T and PI circuits are two specific attenuator circuits in electronics, whose topology has the form of respectively the 'T' letter and the Greek Letter 'Π'. The configuration of each circuit is given in figure 2. An attenuator is an electronic device that reduces the power of the signal. Any T circuit can be transformed to an equivalent PI circuit: The Delta-Wye transformation. The T is equivalent to the Wye (or Star) form, while the PI is equivalent to the Delta form.



(a) T circuit (b) PI circuit

Figure 1: The configuration of T and PI circuit

The resistance of the T network (R1, R2, R3) can be found from the resistances of the equivalent PI network and vice-versa with the following equations:

$$R_1 = \frac{R_A * R_B}{R_A + R_B + R_C} \qquad R_A = \frac{R_1 * R_2 + R_1 * R_3 + R_2 * R_3}{R_2}$$

$$R_2 = \frac{R_B * R_C}{R_A + R_B + R_C} \qquad R_B = \frac{R_1 * R_2 + R_1 * R_3 + R_2 * R_3}{R_1}$$

$$R_3 = \frac{R_A * R_B}{R_A + R_B + R_C} \qquad R_C = \frac{R_1 * R_2 + R_1 * R_3 + R_2 * R_3}{R_3}$$

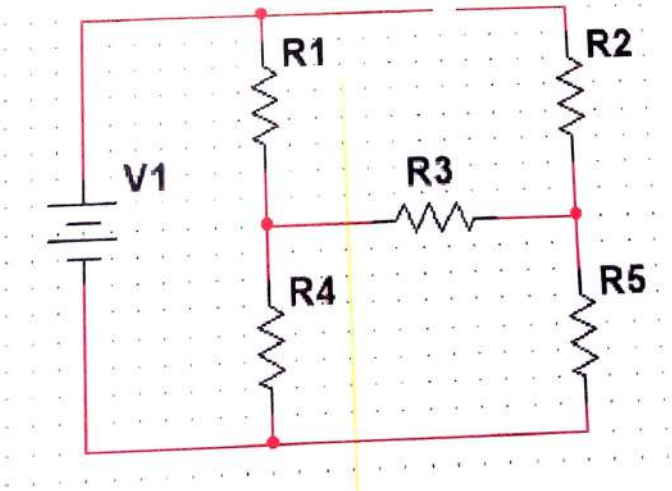


Figure 2: The bridge resistor circuit

Mesh Analysis Method

For the resistors R1, R2, R3 given by the instructor, build the circuit given in Figure 3. Set the voltage VA = 7 V and VB = 12 V.

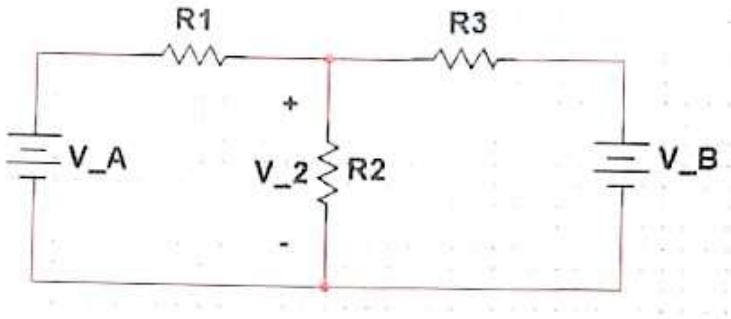


Figure 3. The circuit built in breadboard.

Questions

1. Measure all the currents for the circuit.
2. Measure the voltage across R2, V2 for the circuit given in Figure 1.
3. Solve the given circuits using the mesh analysis method.
4. Compare the results (find the percentage error for all the measured parameters).

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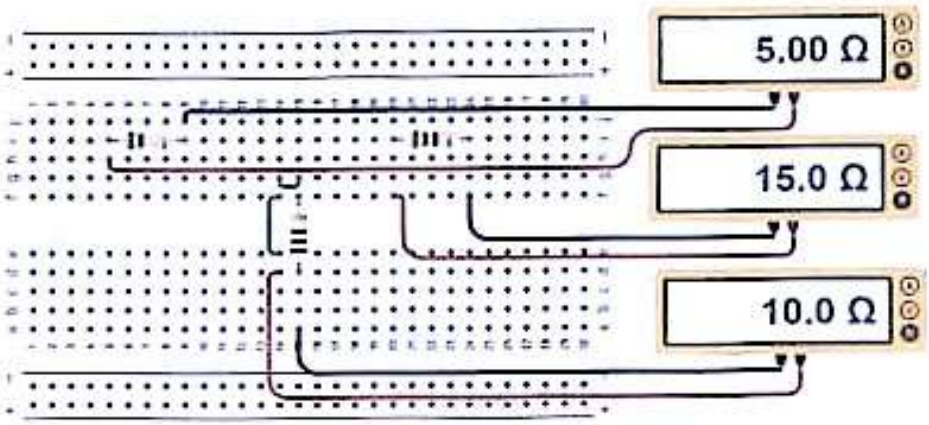
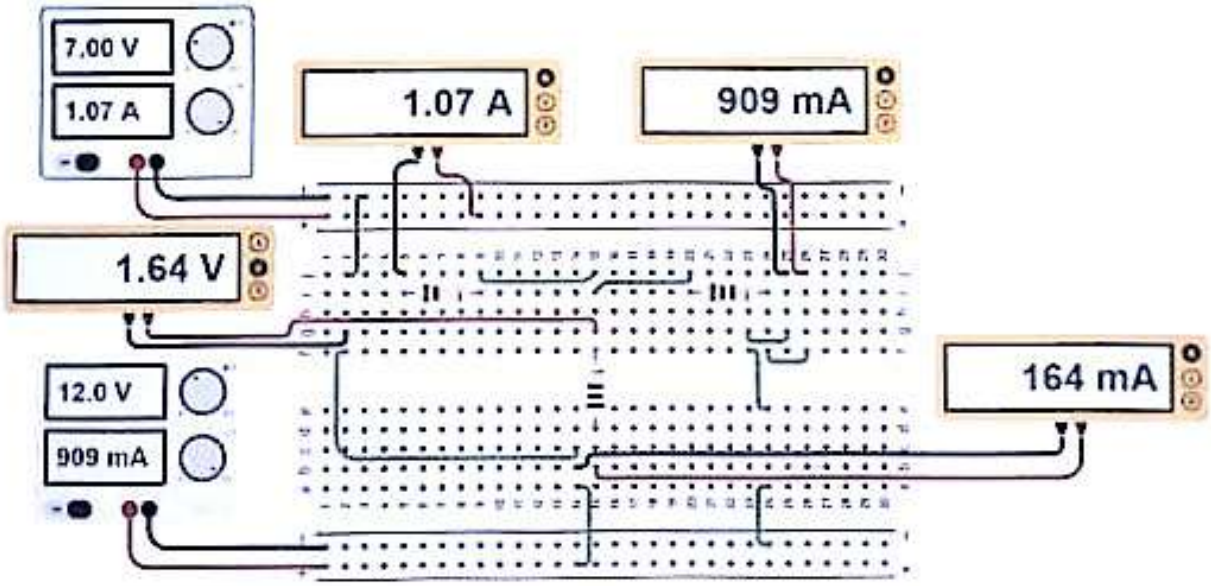
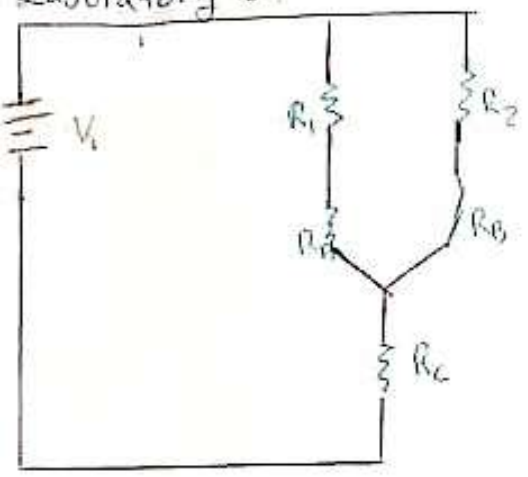
Lab #3

Simulation Link (available for 14 days): https://www.tinkercad.com/things/9cm49YtpBk0-lab3/editel?sharecode=KQc_pb7xfJdeCZIvZLGjKmFR9dtq67qiBbln9B63zHg





Laboratory 3



$R_1 = 3\ k\Omega$ ✓

$R_2 = 3\ k\Omega$ ✓

$R_3 = 4\ k\Omega$ ✓

$R_4 = 3\ k\Omega$ ✓

$R_5 = 3\ k\Omega$ ✓

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$$R_A = \frac{R_3 \cdot R_4}{R_3+R_4+R_5} = \frac{4 \cdot 3}{10} = 1.2\ \Omega$$ ✓

$$R_B = \frac{R_3 \cdot R_5}{R_3+R_4+R_5} = \frac{4 \cdot 3}{10} = 1.2\ \Omega$$ ✓

$$R_C = \frac{R_4 \cdot R_5}{R_3+R_4+R_5} = \frac{3 \cdot 3}{10} = 0.9\ \Omega$$ ✓

$$R_1 = \frac{R_A * R_B}{R_A+R_B+R_C} = \frac{2.4}{3.3} = 0.72\ k\Omega$$ ✓

$$R_2 = \frac{R_B * R_C}{R_A+R_B+R_C} = \frac{1.08}{3.3} = 0.327\ k\Omega$$ ✓

$$R_3 = \frac{R_A * R_C}{R_A+R_B+R_C} = \frac{1.08}{3.3} = 0.72\ k\Omega$$ ✓

$R_1 + R_A = 0.72\ \Omega + 1.2\ \Omega = 1.92\ \Omega$ ✓

$R_2 + R_B = 0.327\ \Omega + 1.2\ \Omega = 0.527\ \Omega$ ✓

$$\frac{1}{R_1+R_A} + \frac{1}{R_2+R_B} = \frac{1}{1.92\ \Omega} + \frac{1}{0.527} = 2.5$$ ✓

1/ $R_{eq} = \frac{1}{1.92} + \frac{1}{0.527}$ ~~$2.5 + R_C = 2.5 \cdot 0.9 = 3.4$~~

After measuring

$R_1 = 3.25\ k\Omega$ $V_1 = 0.7V$ $V_t = V_2 + V_3$ ✓

$R_2 = 3.264\ k\Omega$ $V_2 = 0.7V$ ✓ $V_t = 0.7 + 3.255$

$R_3 = 3.318\ k\Omega$ $V_3 = 3.255\ V$ $V_t = 3.955$ ✓

$$|\%\varepsilon| = \frac{3.955}{3.4} = 1.1\%$$ ✓

$$I_1 = \frac{V_1}{R_1} = \frac{0.7V}{3.25} = 0.21 \times 10^{-3}\ mA$$ ✓

$$I_2 = \frac{V_2}{R_2} = \frac{0.7V}{3.264} = 0.214 \times 10^{-3}\ mA$$ ✓

$$I_3 = \frac{V_3}{R_3} = \frac{3.255}{3.318} = 0.98 \times 10^{-3}\ mA$$