جامعة بيرزيت

BIRZEIT UNIVERSITY

Experiment 2

Impedance Matching and Internal Resistance

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Data:

Note: max voltage 8 volts!

RL(KΩ)	I(mA)	I (mA)	I (mA)	PL = I RL (mW)
0.1	7.27	0.1375516	52.8529	5.28529
0.3	6.15	0.1626016	37.8225	11.34675
0.5	5.32	0.1879699	28.3024	14.1512
0.7	4.69	0.2132196	21.9961	15.39727
0.8	4.43	0.2257336	19.6249	15.69992
0.85	4.31	0.2320186	18.5761	15.789685
0.9	4.2	0.2380952	17.64	15.876
0.95	4.09	0.2444988	16.7281	15.891695
1	3.99	0.2506266	15.9201	15.9201
1.05	3.89	0.2570694	15.1321	15.888705
1.1	3.81	0.2624672	14.5161	15.96771
1.2	3.63	0.2754821	13.1769	15.81228
1.5	3.19	0.3134796	10.1761	15.26415
2	2.66	0.3759398	7.0756	14.1512
3	1.99	0.5025126	3.9601	11.8803
5	1.33	0.7518797	1.7689	8.8445
7	0.99	1.010101	0.9801	6.8607
10	0.72	1.3888889	0.5184	5.184
20	0.37	2.7027027	0.1369	2.738

Note: The original datasheet signed by Dr.Khalid
is attached to the end of report

Abstract:

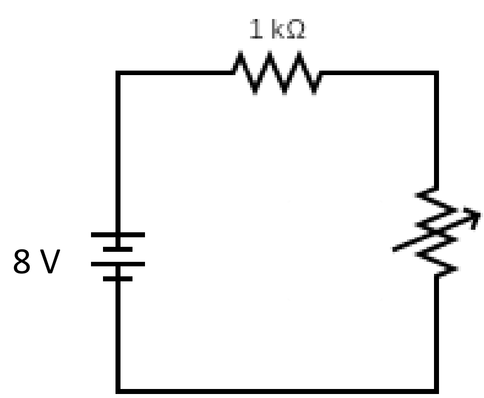
The aim of this experiment determine the emf provided by a voltage source and its internal resistance as well as by measuring the value of the current (I) at various values of RL and using the graphs of (1/I) vs. RL and P(RL) to calculate or estimate the values mentioned above determine the value of RL when the maximum power is consumed in the load. The primary finding was that RL consumes the most power when [R_L = R + Rin].

Introduction:

Apparatus:

Voltage source (8 volts), 1 KΩ resistor, digital multimeter, resistor decade box.

In this experiment we build this electrical circuit :

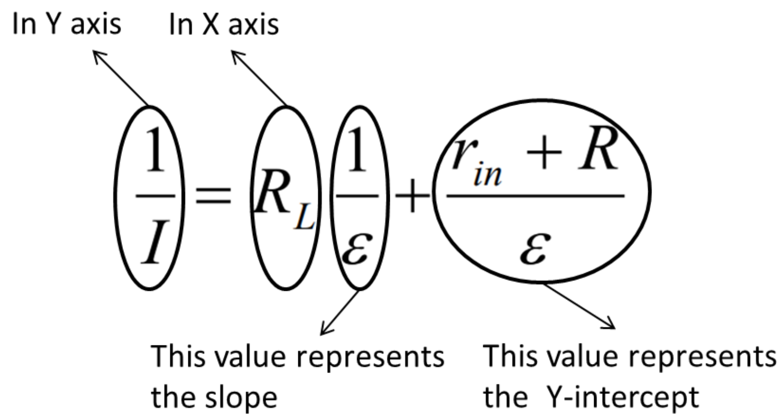


After building this electrical circuit in which the electromotive force is equal to 8 volts, we change the value of the variable resistance according to the values mentioned above in the data, to find out the current values at each different value of the resistance, This enables us to calculate the value of the internal resistance in two ways.

<u>The first way :</u>

From the equation :

$$\frac{1}{I} = R_L \frac{1}{\varepsilon} + \frac{r_{in} + R}{\varepsilon}$$



<u>The second way :</u>

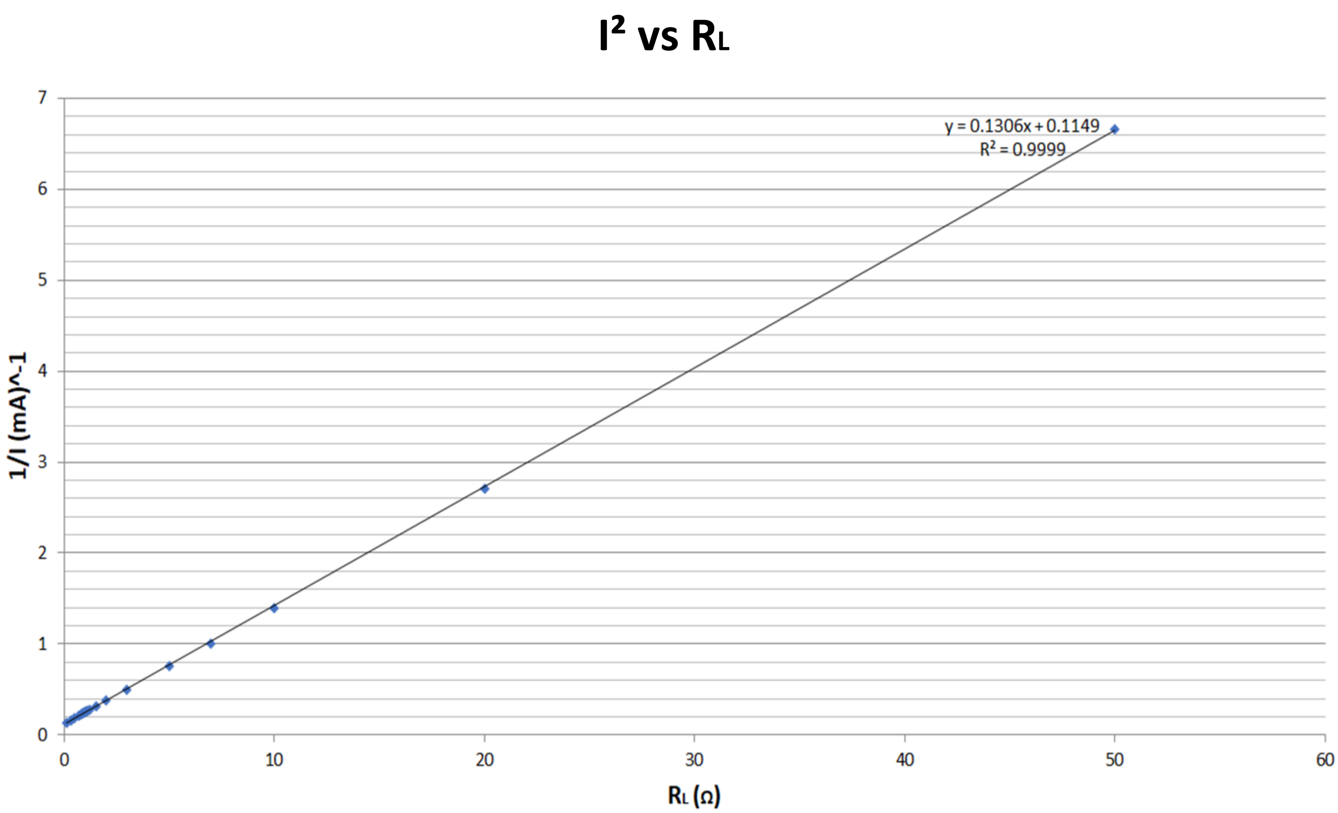
If we find the maximum value of the equation between power and resistance, it will represent = $R_{ext} + R_{in}$.

◊ After calculating the value of the internal resistance with the above mentioned methods, we calculate the rate for it.

◊ Voltage sources typically have low internal resistance (a few Ohms or less), in actual circuits an extra resistor is connected in series with the source to create the conditions for maximum power transfer for high values of (RL). While the source perceives this additional resistance as an additional load resistance, (RL) perceives it as an additional internal resistance. In light of this, this Resistance aids in preventing loading issues and satisfying the requirement of impedance matching for high load values. The sole drawback is that a portion of the power supplied to the circuit from the source is lost due to the additional resistance we add.

Data & Analysis:

First way:



In the graph shown above, it is clear that the slope value is 0.1306, and the Y-intercept value is 0.1149, According to the equation shown in the introduction, we perform the following analysis to calculate the internal resistance. →

From $$\frac{1}{I} = \frac{1}{\varepsilon} R_L + \frac{r_{in} + R_{ext}}{\varepsilon}$$

then $$slope = \frac{1}{\varepsilon}$$

$$\varepsilon = \frac{1}{slope} = \frac{1}{0.1306}$$

$$\varepsilon = 7.6569$$

Hence $$y\text{-}intercept = \frac{r_{in} + R_{ext}}{\varepsilon}$$

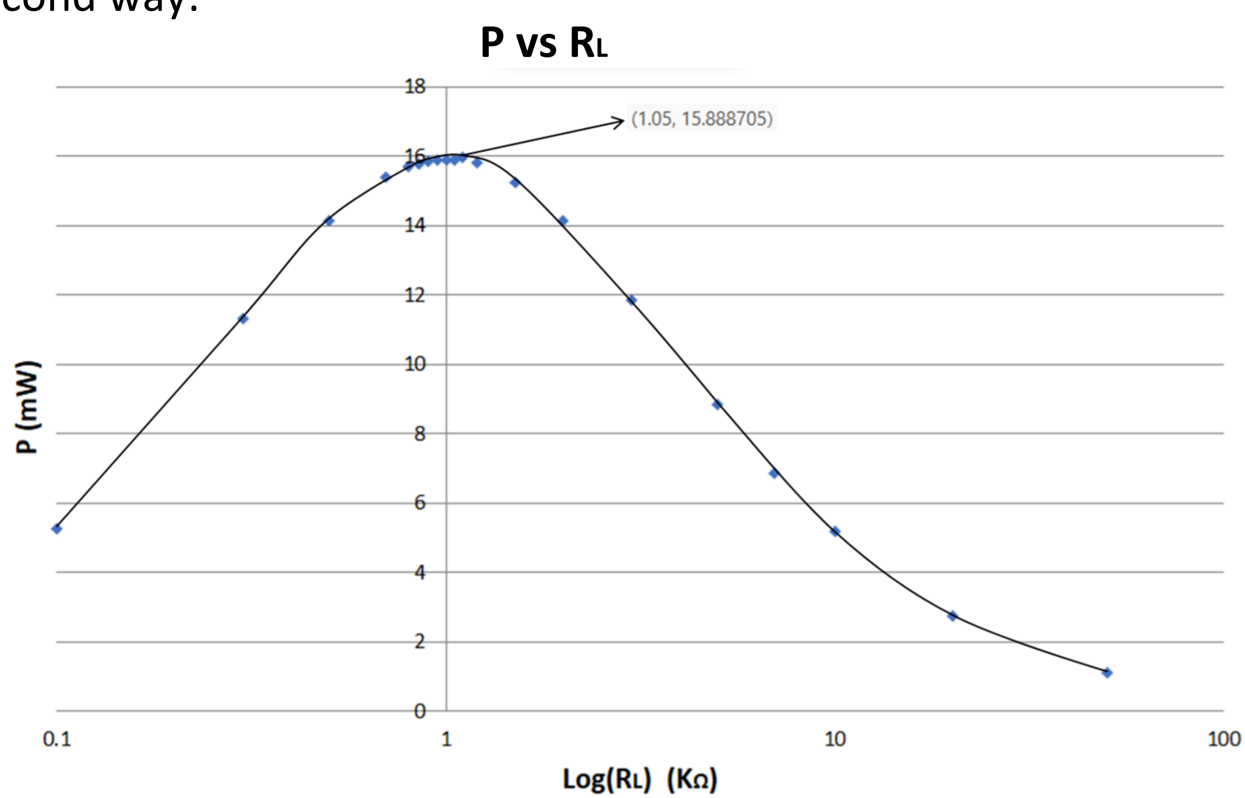
$$\varepsilon * y\text{-}intercept = r_{in} + R_{ext}$$

$$7.6569 * (0.1149) * 10^3 = r_{in} + 982$$

$$r_{in} = 879.78 - 982$$

$$r_{in} = -102.2\ \Omega$$

Second way:



And now if we apply the condition of maximum power transfer to the load resistance of the same circuit we get: RL = R + rin , We calculate the other value of the internal resistance and then the rate .

From the graph The highest value is (1.11) KΩ

$$H.V = r_{in} + R_{ext}$$

$$1100 = r_{in} + 982$$

$$r_{in} = 118\ \Omega$$

Now we find the average :

$$r_{in} = \frac{118 - 102.2}{2}$$

$$r_{in} = 7.9\ \Omega$$

So the value of the internal resistance is 7.9 Ω .

Conclusion:

Our measurement of internal resistance was 982 Ω, but the actual value is 1 KΩ, which is the sum of all outside resistance. We add this external resistance to establish the maximum power transfer criterion for high values of RL because internal resistance is so minuscule that we cannot experimentally compute it alone. Additionally, it provides more load resistance.

The top graphs show: The first graph depicts the linear relationship between 1/I and R, The power curve is depicted in the first graph, and the internal resistance value is displayed at the x-coordinate of the extreme value. we calculated the internal resistance from the y-intercept and the emf from the slope.

We find that the value of the internal resistance is 7.8Ω, which is an acceptable value.