



## GENERAL PHYSICS LAB 2 - PHYS112

### Experiment 2: Impedance Matching and Internal Resistance

Student: Bayan Alkamel

Student's ID: 1231030

Partner: Malak Jamel

Partner's ID: 1221890

Instructor: Wael Karain

Section: 7

## (1) Abstract:

### Aim of the experiment:

To calculate the internal resistance of the voltage source (8 volts), and find the loading resistance at the maximum power.

### The Methods used:

By changing the values of "Load Resistance" (by the variable resistance in the circuit - decade box-), then reading the different measurements of the current that passing this circuit.

### The main result is:

$$R = 1000 \Omega$$

$$(Y - \text{intercept}) = 0.1248 \text{ (mA}^{-1}\text{)}, \quad \varepsilon = 7.14 \text{ Volts}, \quad r_{in} = -86.08 \Omega$$

$$P_{max} = 16.0525 \text{ (mW)}, \quad RL_{max} = 1050 \Omega, \quad r_{in} = 50 \Omega$$

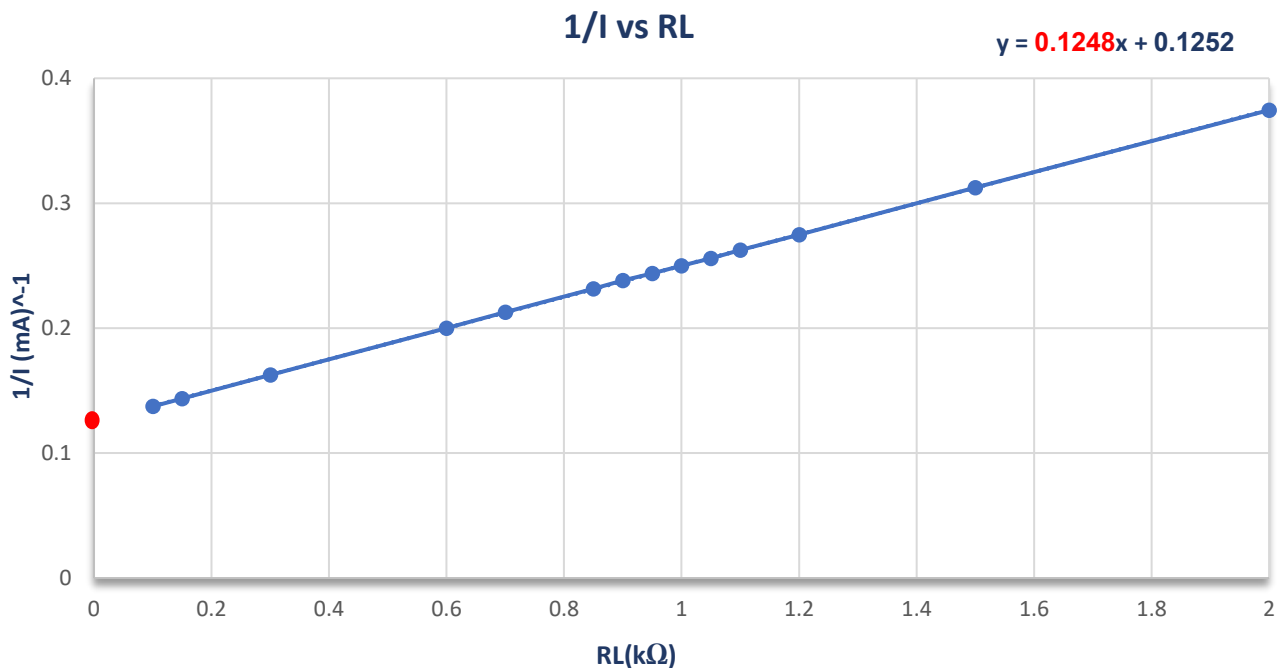
## (2) Data:

Set V power supply = 8 Volts

| $R_L$ (K $\Omega$ ) | I (mA) | $I^{-1}$ (mA) <sup>-1</sup> | $I^2$ (mA) <sup>2</sup> | $P_L = I^2 R_L$ (mW) |
|---------------------|--------|-----------------------------|-------------------------|----------------------|
| 0.10                | 7.28   | 0.137                       | 52.99                   | 5.29                 |
| 0.15                | 6.96   | 0.144                       | 48.44                   | 7.27                 |
| 0.30                | 6.15   | 0.163                       | 37.82                   | 11.35                |
| 0.60                | 5.00   | 0.020                       | 25.00                   | 15.00                |
| 0.70                | 4.70   | 0.213                       | 22.09                   | 15.46                |
| 0.85                | 4.32   | 0.232                       | 18.66                   | 15.86                |
| 0.90                | 4.20   | 0.238                       | 17.64                   | 15.88                |
| 0.95                | 4.10   | 0.244                       | 16.81                   | 15.97                |
| 1.00                | 4.00   | 0.250                       | 16.00                   | 16.00                |
| 1.05                | 3.91   | 0.256                       | 15.29                   | 16.05                |
| 1.10                | 3.81   | 0.262                       | 14.52                   | 15.97                |
| 1.20                | 3.64   | 0.275                       | 13.25                   | 15.89                |
| 1.50                | 3.20   | 0.313                       | 10.24                   | 15.36                |
| 2.00                | 2.67   | 0.375                       | 7.13                    | 14.26                |
| 3.00                | 2.00   | 0.050                       | 4.00                    | 12.00                |
| 4.00                | 1.6    | 0.625                       | 2.56                    | 10.24                |
| 8.00                | 0.88   | 1.136                       | 0.774                   | 6.19                 |
| 15.0                | 0.49   | 2.041                       | 0.240                   | 3.60                 |
| 30.0                | 0.25   | 4.000                       | 0.0625                  | 1.88                 |
| 60.0                | 0.12   | 8.333                       | 0.0144                  | 0.86                 |

### (3) Calculations and Graphs:

1- ( $I^{-1}$  vs RL):



⊗  $Y - \text{intercept} = 0.1248 \text{ (mA}^{-1}\text{)}$

⊗ The slope at (0.1, 0.137) and (0.15, 0.144):

$$\text{slope} = \frac{\Delta(I^{-1})}{\Delta(RL)} = \frac{1}{\varepsilon} = \frac{0.144 - 0.137}{0.15 - 0.1} = 0.14 \text{ (Volts}^{-1}\text{)}$$

$$\varepsilon = \frac{1}{\text{slope}} = \frac{1}{0.14} = 7.14 \text{ (Volts)}$$

$\varepsilon = 7.14 \text{ (Volts)}$

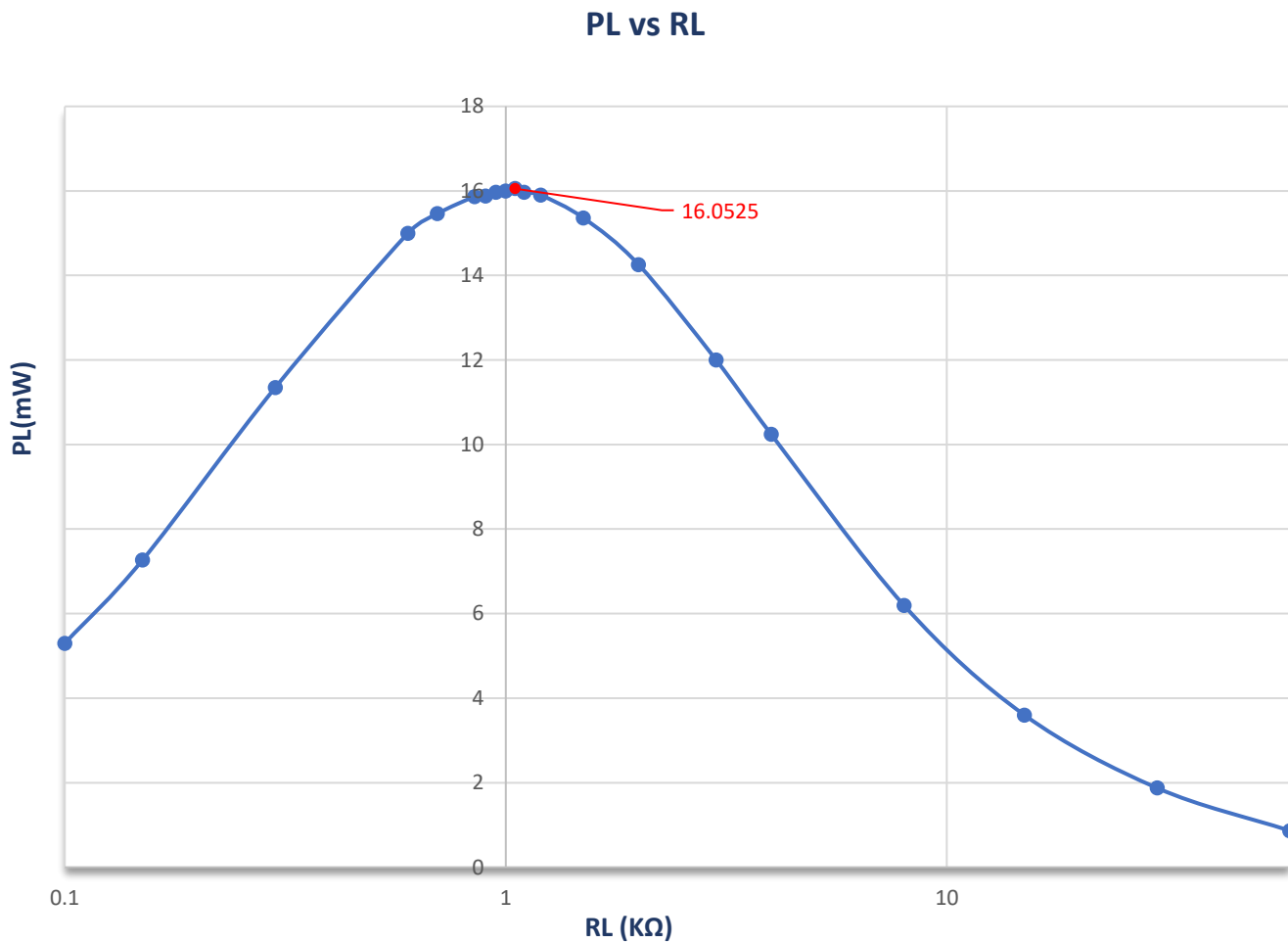
⊗  $\varepsilon \times (Y - \text{intercept}) = R + r_{in}$

$7.14 \times (0.1248 \times 10^3) = 1000 + r_{in}$

$r_{in} = -86.08 \Omega$

$R \approx 1000\Omega$

## 2- (PL vs RL)



– The maximum value of power = 16.0525(mW)

– We find the maximum value of (RL = 1.05 KΩ = 1050 Ω).

$$\textcircled{R} \quad RL = R + r_{in}$$

$$1050 = 1000 + r_{in}$$

$$r_{in} = 50 \Omega.$$

#### **(4) Conclusions:**

This experiment highlighted the significance of impedance matching for maximizing power transfer efficiency in electric circuits.

By changing load resistances and analyzing corresponding currents, we noticed the impact of internal resistance on power dissipation, also we noticed that when  $(R_L = R + r_{in})$ ,  $R_L$  should be at the maximum value then we calculated it from graph 2  $\ggggg$  ( $R_L = 1050 \Omega$ ).

When we calculated  $r_{in}$ , we noticed that the value of internal resistance that we calculated doesn't equal that total of resistance, this is because the  $r_{in}$  in a voltage source is small (few ohm's).

At the beginning of the experience, we set  $V$  power supply = 8 volts, and we calculated it from the graph 1  $\ggggg$  ( $\epsilon = 7.14 \text{ Volts}$ ), this difference between two values of  $\epsilon$  is acceptable due to the voltage "small value" come from the internal resistance ( $r_{in}$ ).